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ABSTRACT

This unit, designed for primary grades of the elementary schools, focuses on weather and is divided into the following five major parts: Weather Affects Man and His Environment; Air, Wind, and Weather; Clouds and Humidity; Precipitation; and Micro-Environments. Each part includes a list of the concepts to be taught, the behavioral objectives and the expected student criteria for evaluation, pretests and posttests, background information relating to the various topics, and suggested instructional sequences and student data sheets. Most of the activities are outdoor oriented and are designed to take advantage of the various weather conditions possible throughout the year. A bibliography lists additional resource materials including books relating to weather, films and filmstrips, available kits and a directory of distributors. (MLB)

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ENVIRONMENTAL ECOLOGICAL EDUCATION PROJECT

Parkway School District
Chesterfield, Missouri

DR. WAYNE FICK, Superintendent
VERLIN M. ABBOTT, Project Director

Unit: Everything You've Always Wanted to Know About Weather but Were Afraid to Ask
Revised 1972

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I

EVERYTHING YOU'VE ALWAYS WANTED TO KNOW ABOUT WEATHER BUT WERE AFRAID TO ASK

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SETTING

This model unit is designed to create an awareness of the environment. It is geared toward emphasizing weather conditions directly observable in the Parkway area.

The unit is designed for primary grades, and is particularly well suited for grade three.

Most of the activities connected with this unit will take place outside the confines of the classroom, where the children will demonstrate their understanding of weather by measuring, predicting, observing, discovering, comparing, and constructing.

The unit will supply the children with interdisciplinary experiences. The outstanding activities have been starred. An effort has been made to provide for all the primary levels of learning, as well as for individual differences, interests, and capabilities.

Because of the side scope of this unit, we have provided a complete Table of Contents. Each part contains data sheets which follow the instructional sequence. It is particularly recommended that the teacher look over the bibliography of suggested materials, and that he refer to it frequently in conjunction with teaching the unit.

This unit may be used throughout the year, taking advantage of whatever possibilities the weather provides.

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WEATHER IS FULL OF THE NICEST SOUNDS

by
Aileen Fisher

Weather is full
of the nicest sounds:
it sings
and rustles
and pings
and pounds
and hums
and tinkles
and strums
and twangs
and whishes
and sprinkles
and splishes
and bangs
and mumbles
and grumbles
and rumbles
and flashes
and CRASHES.
I wonder
if thunder
frightens a bee,
a mouse in her house,
a bird in a tree,
a bear
or a hare
or a fish in the sea?
Not me!

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PART I

WEATHER AFFECTS MAN AND HIS ENVIRONMENT

CONCEPTS
(Part I)

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I. Weather affects man's occupation.

II. Seasons determine man's way of life. Seasons are caused by the angle at which the sun's rays strike the earth.

III. Man has caused harmful weather (pollution) and has developed various instruments for its control.

IV. Just as people in the past observed signs of changing weather, so can we by using our senses.

V. Ancient myths and superstitions about weather forces created many beliefs which seem strange to us today.

VI. Many careers are related to the prediction, measurement, and control of weather.

BEHAVIORAL OBJECTIVES

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Concept Number		
I.	1.	Upon completion of the unit, all students will be able to illustrate and label types of weather which affect man in six given occupations.
II.	2.	After studying the four seasons and how they determine man's way of life, seventy-five percent of the students will be able to match particular items or activities with the season(s) with which they are most likely to be associated.
II.	3.	After completing the section on seasons, eighty percent of the class will be able to correctly identify the area in which summer is taking place on a diagram of the earth in relation to the sun.
III.	4.	After completing the section dealing with man's effect on weather, fifty percent of the students will be able to recognize three ways in which man affects the weather from a given set of illustrations. In addition, fifty percent of the class will be able to list the four types of pollution caused by man.
III.	5.	Fifty percent of the class will be able to list three ways in which man can control pollution.
IV.	6.	At the conclusion of the unit eighty-five percent of the children will be expected to observe weather conditions outside the classroom and list what they see, hear, and smell.
V.	7.	At the end of the discussion on superstitions, seventy-five percent of the class will be able to write two superstitions about weather signs.
VI.	8.	Upon completion of the unit, seventy-five percent of the students will be able to list two careers that are related to weather.

PRE-POST TEST
(Part I)

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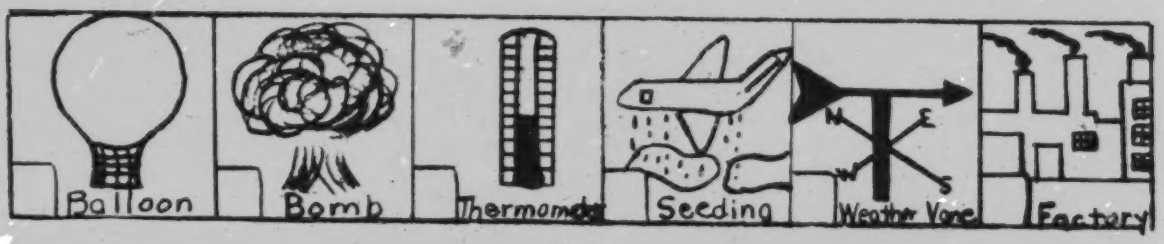
Behavioral
Objective No.

4. 1. Put an X in the boxes which show how man affects the weather.



2. 2. Put an S in the boxes which apply to Summer. Put an F in the boxes which apply to Fall. Put a W in the boxes which apply to Winter. Put an SP in the boxes which apply to Spring.

4. 3. Name the four types of pollution caused by man.

a.

b.

c.

d.

5. 4. List three ways in which man can control pollution.

a.

b.

c.

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Behavioral Objective No.

1. 5. Draw and label a picture which shows:

   a. Bad weather for a sailor

   b. Good weather for a farmer

   c. Bad weather for a forest ranger

   d. Good weather for a picnicker

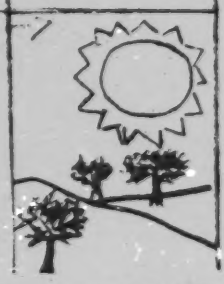
   e. Good weather for a pilot

8. 6. List two occupations of people who make their living predicting, measuring, or controlling the weather.

   a.

   b.

6. 7. Students will list (or orally relate) in the proper column observed signs of changing weather.

See	Hear	Smell		
				Windstorm
				Rainstorm
				Tornado
				Fair Weather

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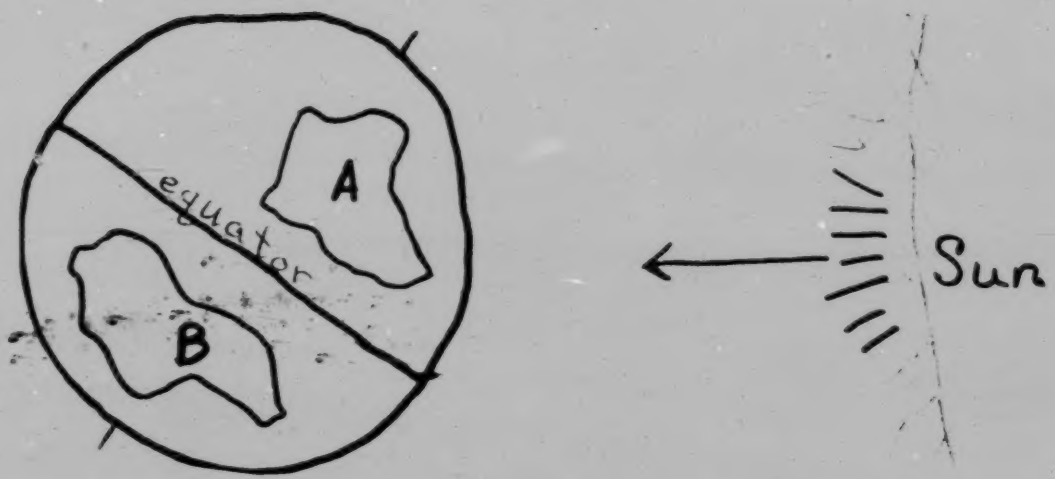
Behavioral
Objective No.

7.

8. Write two superstitions about weather signs.

3.

9. In the diagram below, would Country A or Country B be having summer? Color your choice green.



ANSWER SHEET
PRE-POST TEST
(Part I)

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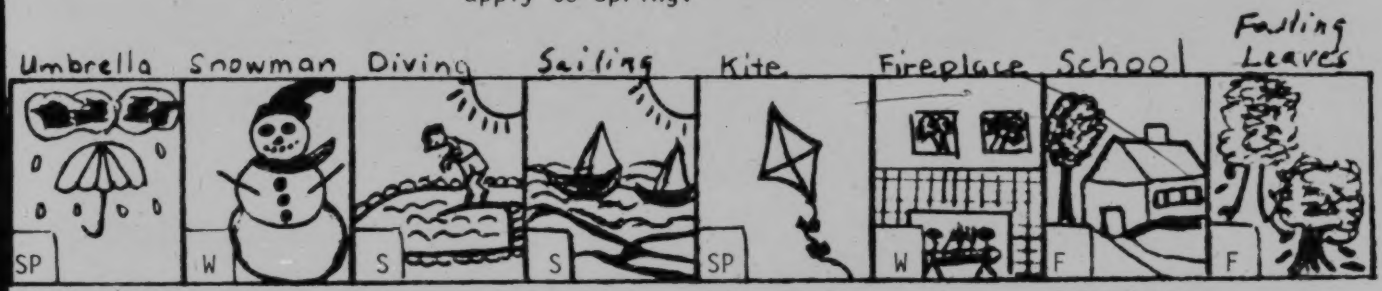
Behavioral Objective No.

4. 1. Put an X in the boxes which show how man affects the weather.

2. 2. Put an S in the boxes which apply to Summer. Put an F in the boxes which apply to Fall. Put a W in the boxes which apply to Winter. Put an SP in the boxes which apply to Spring.



We have rain in all seasons.

Kite flying in summer & fall also

School can be year-round.

4. 3. Name the four types of pollution caused by man.

a. Noise

b. Air

c. Water

d. Land

5. 4. List three ways in which man can control pollution. Some possible answers are:

a. control factory pollution

b. construct sewage treatment plants

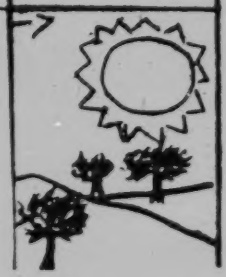
c. control car exhaust emissions

Behavioral
Objective No.

1. 5. Draw and label a picture which shows: Examples of acceptable answers are:
   a. Bad weather for a sailor - storm
   b. Good weather for a farmer - sun and/or rain
   c. Bad weather for a forest ranger - dry
   d. Good weather for a picnicker - sunny
   e. Good weather for a pilot - clear

8. 6. List two occupations of people who make their living predicting, measuring, or controlling the weather.
   a. Meteorologist
   b. Cloud seeder

6. 7. Students will list (or orally relate) in the proper column observed signs of changing weather. Answers will vary.

See	Hear	Smell		
				Windstorm
				Rainstorm
				Tornado
				Fair Weather

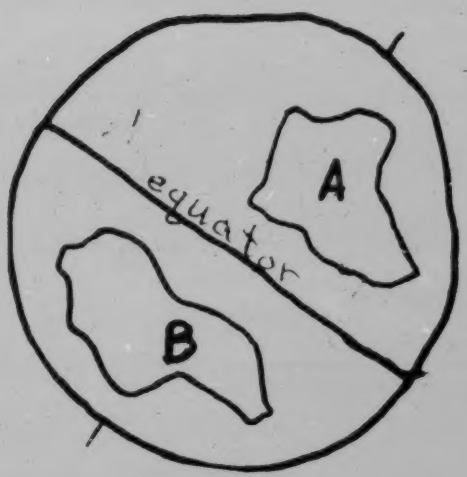
BEST COPY AVAILABLE

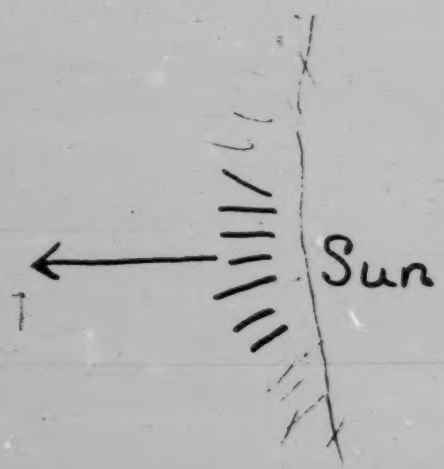
Behavioral
Objective No.

7. 8. Write two superstitions about weather signs.

answers will vary

3. 9. In the diagram below, would Country A or Country B be having summer? Color your choice green.





Shaded area (A) should be colored green.

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BACKGROUND INFORMATION
(Part I)

"What is it that molds the life of man? The weather. What makes some people black and others tan? The weather. What makes the Zulu live in trees, Congo natives dress in leaves, while others go in furs and freeze? The weather."[1] Weather affects all people in all occupations, no matter who they are or what they do. Weather changes from day to day and from season to season, affecting people every day.

Occupations Affected by the Weather: (may be extended)

1. Farmers - "Make hay while the sun shines." The farmer must know the best season, weather, and time to plow, sow, and harvest in order to make a success of his farm.

2. Fruit growers must be aware of frosts, insects or diseases requiring spraying, rotting, etc.

3. Forest rangers know that certain weather conditions spread fire more readily. Wind direction and the summer fire season are important factors to consider when the lives of millions of trees are at stake.

4. Sailors, captains, and mates all are dependent on the weather since their lives, ships, and cargos may be endangered by unfavorable conditions.

5. Pilots and aviators receive messages of existing weather and what lies ahead. Weather circumstances may determine how and where they fly.

6. Trainmen must know the weather and its effects in order to prevent wrecks which saves lives, and to control refrigeration.

7. Outdoor workers should know the daily weather to protect their health, determine how to dress, and protect the materials they are working with.

8. Sportsmen are concerned about the weather since they must plan participation in sports which depend on the weather. Sports such as baseball, hockey, polo, golf, skating, skiing, horseback riding, etc. are all affected.

Seasons

The most notable changes in weather patterns are seasonal variations. Seasons are determined by the angle at which the sun's rays strike the earth. The part of the earth which is slanted toward the sun receives the most direct rays because they pass through less of the atmosphere to reach the earth's surface. The earth's revolution places the earth in position so that the northern hemisphere is tipped toward the sun part of the year and the southern hemisphere is in that position at the opposite point in the revolution. This is possible because the earth is slanted 23 1/2 degrees on its axis.

[1]W. J. Humphreys

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The four seasons, winter, spring, summer, and fall, all play an important role in determining man's dress, work, play, foods consumed, and physical features of the land. During the winter months the days are shorter and the nights are longer. As a result, much more leisure time is spent indoors. In order to keep warm in winter people wear darker and heavier clothing. The types of games played are appropriate for the cold weather. Foods served in winter are usually much hotter and heavier than those eaten in the summer. Nature dries out more than ever during the winter months: there are no leaves on deciduous trees; the grass is dormant; and most bright colors disappear. With the advent of spring come the birds, flowers, mild winds, swelling rivers from melting snows, and the shedding of heavy clothes. Color bursts out in nature. Clothing, activities, food, etc. are changed. On March 21st the length of day and night are equal; from then on the length of the day increases. This is the Vernal Equinox. People will be busy observing changes outside as often as possible. "Spring fever" affects man at this time of the year. Working indoors is difficult since most people desire to be outdoors. The length of day increases even more during the summer months, especially with Daylight Savings Time. People plan picnics, go to the beach, relax in the sun, and spend much time outside. The heat or temperature reaches its highest point during the summer months, causing people to dress in cooler clothing and to eat lighter foods. Many families now resort to air-conditioning as a relief from the summer heat. With the coming of fall, the day once again begins to grow shorter. The winds become cooler and more brisk. On September 21st the days and nights are the same length. This is called the Autumnal Equinox. Leaves fall and animals prepare for the long, cold winter months ahead. People choose clothes that are darker and warmer, leading into the winter months.

Just as weather affects man, man also plays an important part in affecting the weather. Rural areas are composed of mostly natural land forms. Cities reshape these natural land forms with the aid of man. Urban areas replace fields and woodlands with houses, factories, power stations, etc. Since cities are built by man, he is indirectly the causal force for the change in our environment. With the growth of cities we also experience a change in the physical and chemical makeup of our environment. Pollution is one of the dangerous outgrowths of the development of cities and of the industrial era. When pollution takes over and remains uncontrolled, buildings get dirty and crumble, metals corrode and dissolve, and a gradual deterioration occurs. Other results and changes include less daylight, radiation, rain, more fog, showers of scuzz and grime, windflow fluctuations, snow melting earlier, flowers blooming sooner, and a warmer atmosphere cuasing higher temperatures.

Pollution applies to various topics; for example, we have air, water, visual, and sound pollution. Most references in this section will concern air pollution. Some air pollution is composed of mineral dusts from soils, quarries, roads, pollen, and ragweed. Other solid and gaseous forms come from combustion products, industrial smoke, gases and fumes from exhausts, small particles of carbon, soot, and ash, etc. All of this material, which has been extracted from the city into the air, provides more particles on which water vapor may anchor itself to eventually form a cloud. The major causes of pollution may be traced back to man through his building of factories, steel mills, incinerators, quarries, motor vehicles,

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railway engines, shops, etc. Air pollution is sometimes broken down into two categories: (1) smoke and sulfur dioxide, and (2) gaseous hydrocarbons. Pollution may also be classified by its mixtures. Smaze is a combination of smoke and haze. Smog occurs when there is a temperature inversion, which is an upside-down condition of the atmosphere. The surface air is cooler than the high air. Because the surface air is denser and heavier, it traps the polluted materials inside, thus prolonging the polluted condition of the city's air. A typical day spent in an industrial city may produce various physical symptoms. Smoke and haze cause tears and burning sensations in the eyes, scratchy throats, raspy voices, and difficulty in breathing. Air pollution may result in death if poisons and gases are mixed in with the smog. For example, sulfur dioxide gas and smog equals suffocation. One potential problem we have at present is the amount of carbon dioxide expelled into the atmosphere every year. In the next 50 years the amount will probably quadruple. Over a period the resultant rise in temperature of 1° to 2° Fahrenheit will eventually melt the Greenland Arctic ice fields. The result would be a rise in the ocean level culminating in the swamping of many ports and seacoasts.

Man has taken some measures to control, combat, and improve our negative weather conditions and pollution problems. For example, government control has resulted in the replacement of much of our coal with coke, oil, and gas. Anti-smoke laws have been incorporated by the government in many areas. Industries have devices such as settling and cyclone chambers, automatic stockers, scrubbers (water spray devices), and electrostatic precipitators for pollution control. Even with present efforts, much more can be done.

Attempts have also been made to control or harness weather for the benefit of many. Although some ideas will result in better weather conditions in some areas, the end result is potentially dangerous to others.

Proposed changes:

1. Blacken the Arctic ice with carbon. This would reduce the loss of solar energy by reflection and would make the northern wastelands more habitable.

2. Reduce evaporation in large areas of the ocean. This proposal would act as a sealer of evaporation and control rainfall, thus reducing some tropical storms.

3. Create a five-mile thick ice cloud over the Arctic by using H bombs. This would prevent the escape of infrared radiation, thereby improving the world climate.

4. Dam the 55-mile wide Bering Strait. Arctic water would be pumped to the Pacific, then to the warm Atlantic waters, improving the year-round climate.

5. Eliminate Los Angeles smog by submerging a 100-by-200 mile polyethylene shield 100 feet under the water. This would cause more thunderstorms and get rid of air pollution.

As a result of these proposed changes man could possibly be faced with even larger problems, such as more severe winter storms in some areas, the threat of a new ice age, more deserts, droughts, killing freezes, economic

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changes, etc. Perhaps it is best that man does not try to control all aspects of weather, at least until more knowledge of controlled results is gained.

People have always cared about the weather. Long ago hunters, farmers, sailors, fishermen, woodsmen, and builders were as concerned about the weather as we are today. But they lacked the know-how and technology to forecast the weather each morning. Not only did they lack radios, television, telephones, and newspapers to convey weather reports; there was no Weather Service to send out the reports.

People depended upon their observations to tell them what the weather would be. They observed the sunset and sunrise skies. They watched clouds. Farmers held moistened forefingers in the air to tell them the wind direction and velocity. They looked to the distant hills and mountains and listened to sounds. People watched plants, animals, bees, and ants to see how they reacted to changed in the weather, and then made up sayings about their observations. For instance:

When spider webs in the air do fly,
The spell will soon be very dry.

All over the world similar adages were invented. Some of them can still be depended upon; others cannot.

Weather forecasters are learning more each day about the weather, but there is still much to learn. In the meantime you can have fun trying to predict the weather yourself. Try the following methods:

1. If the wind is swinging around the points of the compass "clockwise" the weather will clear. If it swings "counter-clockwise," a storm is on the way.

2. The higher and more distant clouds appear, the more gradually the weather will change.

3. Bad weather is foretold by the clouds breaking up into wisps, curls, and catches in the distance. These cloud changes increase, followed by a murky overcast.

4. Smoke can tell us something about the coming weather. If it rises straight up into the sky or bends just slightly, good weather can be expected.

5. Expect rain or snow if:

   The smoke from chimneys right ascends,
   Then, spreading back to earth, it bends.

6. Since smoke also shows wind direction, that helps to predict the weather.

7. The following proverbs are quite true:

   The wind from the northeast,
   Neither good for man or beast.

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When the wind is in the south,
The rain is in its mouth.

The wind in the west
Suits everyone best.

A high wind prevents frost.

8. Sunrise and sunset can help foretell the weather.

If the sun goes pale to bed,
'Twill rain tomorrow, it is said.
Evening red and morning gray
Help the traveler on his way;
Evening gray and morning red
Bring down rain upon his head.

Sunrise and sunset predict the following day's weather. Good weather if foretold by a red sunset; a red sunrise hints of stormy weather ahead.

9. Hundreds of additional sayings exist in every language and are true and reliable.

If it has been cloudy for a day or two and then starts to rain, the rain will last. If it starts to rain after the clouds have quickly gathered, the rain will be brief.

Dew on the grass foretells a nice day.

Dew and frost together predict good weather.

Another sign of good weather is cobwebs on the grass.

These signs are dependable because dew, frost, and cobwebs can be found when the air is calm, clear, and dry; they are portents of good weather.

10. Of all the signs in the sky, people seem to like the rainbow best. Long ago the Norsemen called it "The Bridge of the Gods."

Although the rainbow has always been considered a sign of changing weather, some people believe that specific colors of the rainbow tell of the type of weather to come.

If the green be large and bright in the rainbow,
It is a sign of continued rain.

If red is the strongest color,
There will be rain and wind together.

If blue is the strongest color,
It will be fair soon.

<u>These observations, however, cannot be depended upon</u>.

A reliable sign is that a rainbow in the forenoon promises rain; a rainbow in late after foretells fair weather.

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11. The following are some additional signs to observe along with the reasons why they can usually be depended upon:

a. Dark clouds in the west,
Stay indoors and rest.

Much of the weather in our country approaches from the west.

b. When high clouds and low clouds do not march together,
Prepare for a blow and a change in the weather.

Winds blow clouds. Winds which shift and change usually indicate an approaching weather front, in which lower and upper winds move in different directions.

c. When clouds move down and turn dark gray,
A rainy spell is on the way.

Rain begins when low, gray rain clouds are above you.

d. A ring around the sun or moon
Brings rain or snow upon you soon.

Tiny ice crystals high in the air scatter the sunlight or moonlight in the form of a ring or halo. This is the high tip of a warm front which brings rain or snow when the lower part reaches you.

e. When windows won't open and salt clogs the shaker,
The weather will favor the umbrella-maker.

Humid air causes these conditions, with the probability that rain is on the way.

f. Smoke drifting lazily close to the ground,
Tells us that rain may be coming around.

Smoke drifts along slowly because warm, damp air has less pressure than cool, dry air and thus is less able to push the smoke upward.

g. Welcome the sound of crackling hair;
It tells of weather clear and fair.

Dry air, which foretells clear weather, causes hair to crackle.

h. When radio programs are peppered with static,
There'll be lightning and thunder and weather aquatic.

Lightning flashes cause the crackling static sound. If you hear static, yet do not see lightning, the lightning is far away or within the clouds, but there is a good chance of a thunderstorm soon.

i. Hark to the cricket, whose chattering sound
Will tell you how hot is the air near the ground.

Try counting the number of chirps a cricket makes in 15 seconds. Add 37, and you should have the temperature of the air. Check your calculations

with a thermometer.

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j. Flies and mosquitoes are biting and humming;
• The swallows fly low; a rainstorm is coming.

Some people believe that insects fly lower in damp air because the dampness makes their wings heavy. Since swallows are insect-eaters which catch their food while flying, they fly low when the insects do.

Primitive people living long ago had many practices and beliefs concerning the weather which seem strange and fantastic to us today.

Many early civilizations believed that one of their gods rode the storm and controlled the bolt of white lightning. In Egypt it was the god of evil, Set; in Greece it was Zeus; in Italy it was Jupiter, or Jove. Native American Indians thought that the lightning was a swift white bird which darted out of a stormy sky; thunder was the beating of its huge wings. (This was the "thunderbird.")

The ancient Norsemen made Thor their god of thunderstorms. He was pictured with flaming red hair carrying a magical hammer. As he rode in a chariot drawn by goats, he hurled the hammer to earth on a flash of lightning. Thunder was believed to be caused by the chariot wheels on the high storm clouds. Thor's hammer always returned to his hand, ready to be used again as a thunderbolt to destroy his enemies, the giants.

Sometimes today the Scandinavian farmers find bits of iron or stone as they plow their fields. They say that these bits are pieces of Thor's hammerhead and they call them "thunder-stones." Actually, they are usually either small meteorites or long-buried Stone Age tools. We still speak of Thor, however, when we name the days of the week. Thor's day has become Thursday.

The ancient Greek and Roman people thought that the winds were the children of the sky and the earth. Aeolus, their king, kept them imprisoned in a deep cavern where they roared without ceasing until set free by Jupiter, king of all gods. The winds lived with Aeolus on his island, where he kept them in bags, freeing them as he chose.

The early American Indians believed that one of the four wind gods lived in each of the four corners of the earth.

People who believed in witches and wizards used to entreat their help with the wind. In Scotland it was thought that witches could start a wind by dipping a rag in water, beating it three times on a stone, and repeating a magical chant.

In Finland wizards used to sell wind tied in a rope with three knots to sailors. A moderate wind would blow if the first knot were untied; a stronger wind came when the second knot was untied; the third knot turned loose a hurricane. The sailors who live in the islands north of Scandinavia still "buy" wind knotted into handkerchiefs.

The crews of early clipper ships had many superstitions about the wind. They believed they could call the wind by whistling, and that scratching on the mast made the wind come. The sailors made up and sang sea chanteys

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because they believed they could sing up a wind.

There are people in West Africa who still believe that high on a mountain the wind god named Bagda keeps the winds locked in great pots and lets them go when he wishes.

Because weather is so important in our lives, there are many occupations related to research about and prediction of weather. The meteorologist is a scientist who deals with the atmosphere and its phenomena as related to weather and weather forecasting. According to Mrs. Slaughter at the St. Louis International Airport Weather Station, other men work with the meteorologist. Their job is to keep track of the various phases of weather. These include forest rangers, who watch for fire in dry weather; men who monitor the pollution levels in the cities and counties; hydrologists, who observe the river levels; marine forecasters, who observe the coastal weather; agricultural advisors, who inform the farmers of significant weather factors; and forecasters, who use satelite readings to further predict weather.

That weather researchers have made efforts to gain further knowledge of weather and how to predict it is shown by the production of such instruments as radar, balloons, weather satelites, etc. Through research man has devised ways to seed clouds with dry ice and silver iodide to produce rain. Upper air observations are made by aircraft weather reconnaissance pilots who are responsible for making detailed weather observations or investigations from aircraft in flight.

The careers as television or radio weather announcers are important, as these people relate the weather news daily with accuracy and clarity to a weather-conscious audience.

Universities in the St. Louis area which offer specialized courses in the Science of Meteorology are St. Louis University, St. Louis Mo.; Northern Illinois University, DeKalb, Ill.; and the University of Missouri, Columbia, Mo. Nationwide, Massachusetts Institute of Technology should be noted as it is considered an excellent school for preparing for a career in this field.

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INSTRUCTIONAL SEQUENCE
(Part I)

Concept Number

I. *1. Each child, or the entire class, may engage in a project of assembling a scrapbook on various occupations and activities, showing how each one is affected by weather.

*2. A bulletin board depicting various occupations and the weather which affects each may be constructed. Pictures, newspaper articles, magazines, photographs, and surveys involving friends, parents, and others may be included.

3. Skits may be produced for various occupations.

4. Explanations may be given about what constitutes favorable or unfavorable weather for particular occupations in oral or written form.

5. A collage on various occupations may be made. Incorporate weather whenever possible.

6. Poems or songs may be written to show the relationship of weather and occupation.

7. List occupations beginning with letters A to Z and show the effect of weather on each in oral or written form. Illustrations may accompany the explanations.

8. Make a list of things you can do in hot weather and things you can do in cold weather. Pictures may be drawn in place of written lists. Activities may be pantomimed, and the class can guess in which type of weather each activity is best performed.

*9. Have the children telephone for the recorded weather reports to decide upon suitable clothing for the day. They may call 936-1212 or 862-7670.

II. *10. Create a bulletin board to illustrate all four seasons, or devote four bulletin boards to each separate season. Box sculptures may also be used. Each bulletin board or section may include:

a. Clothing - material scraps, clothesline, construction paper, cardboard, etc.

b. Food - labels may be used.

c. Objects associated with each particular season.

d. Nature's changes with the seasons; nature objects may be exhibited.

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e. Poems and songs associated with the seasons.

f. Ideas or beliefs associated with the seasons.

g. Emotions associated with the seasons.

h. To extend this activity, foods and clothing from areas all over the world may be included in the form of reports.

11. See Data Sheet on "How Temperature Affects the Insect World." Make ditto copies and distribute them to the children. Discuss. Have the students take the data sheets home and listen for insects' sounds; then compare with thermometer. (Data sheet follows activities for Part I.)

*12. "Adopt" a tree or a section of school property to observe through the four seasons.

*13. Schedule a field trip to a farm in the fall and again in the spring.

*14. Visit Soulard Market to observe seasonal changes in kinds of fruits and vegetables.

*15. Draw a diagram or create a mobile illustrating the sun and the earth tilted on its axis to show why we have four seasons.

16. Make a collage of the four seasons.

17. Set up hypothetical situations of temperature, humidity, precipitation, sky conditions, etc. (visual if possible). Have the children connect appropriate foods, dress, activities, etc. with each example.

18. Have each child make a scrapbook on seasons.

19. The following are suggested questions for discussion:

a. How does the weather of each of the four seasons affect man?

b. Why do seasons change?

c. Can you imagine what your life might be like with only one season? Which season would you choose?

d. Did we always have <u>four</u> seasons?

e. Are there four seasons in every part of the world?

f. What holidays are associated with particular seasons? Can you think of a reason why? Are these holdiays celebrated in the same way all over the world?

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Concept Number		
	*20.	Mark with stakes the shadow cast by the flagpole at different times of the day. What is the relationship to the time of day in which the shadow is longest to the time of day which receives the most direct rays of the sun? Take readings of the shadow at different seasons of the year.
III.	*21.	Take a field trip to the city and to the country to see how man causes pollution. Make a comparison study. (See data sheet at the end of this activity section.)
	22.	Make a collection of pictures of objects, people, and places which cause air pollution. This may be extended to cover other forms of pollution (water, noise, visual, etc.).
	23.	Construct miniature models or drawings of pollution control devices.
	*24.	Contact the Environmental Studies Consultant for kit, "No Time to Waste," for classroom use. Refer to Bibliography.
	*25.	Promote a drive in your classroom for helping to clear air pollution or pollution of some type. Ideas may be acquired from local pollution bureaus. (St. Louis County Air Pollution Control Board, 726-1100; Mr. Thomas Hirsch.)
	26.	List and illustrate ways to control weather and state the possible hazards. How can you control weather?
	*27.	Construct or keep a chart of various objects or methods used to predict weather.
	*28.	Have the children clip daily weather forecasts from the newspaper. Keep a chart of pollution levels, temperatures, kinds of weather (rain, sun, wind, etc.).
	29.	Create a model city and a polluted city to show weather and environmental contrasts (use paper, cardboard, clay, etc.).
	*30.	Each child can keep a calendar of daily weather conditions. Make separate masters for each month.
	*31.	Take the children on a trip around the school property to observe evidences of pollution. Plan a project to clean up these conditions.
	*32.	Have the children observe pollution in their own neighborhoods. Draw a picture of the pollution, indicating what kind it is and what can be done to alleviate it.
	33.	Keep a scrapbook of various ways in which man has affected his weather.
	34.	Study the history of industrial and economic developments in urban areas. Committee groups may give oral or written presentations.

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Concept Number		
	*35.	Keep a clean cloth or cotton puff outside the window and watch for evidence of pollution. Contact the Environmental Studies Consultant to coordinate and compare your findings with those of a class in another area of the school district.
	*36.	Make a positive change in the environment. Stop a negative change in the environment.
	37.	Torn bits of paper may be used to create a factory and pollution collage.
	38.	Illustrate ways in which man creates pollution and how pollution affects man.
	*39.	Take a field trip to an industrial city. List adjectives and then write a story describing how you might feel.
	40.	Project yourself into the future. Write a story on possible pollution problems.
IV.	41.	Our five senses help to make life interesting to us. How can we use our five senses during a soft spring shower and/or a rollicking thunderstorm? Show as well the use of our senses for enjoying a snowfall.
	*42.	Take the class outdoors. Have each child wet a finger and put it into the air to determine wind direction and velocity.
	*43.	Take advantage of days when there are observable weather changes (increasing wind, gathering rain clouds, etc.) and walk around outside. Emphasize smells, sounds, sensing moisture in the air.
V.	*44.	Take the class outside to verify verses listed under "Watch the Weather" (see Background Information for this section).
	*45.	Consult the Childcraft series for supplementary material on weather superstitions. (Refer to Bibliography.)
	46.	A legend tells of a pot of gold which waits at the end of the rainbow for anyone who is able to find it. Suppose this were true and you found the pot of gold. How would you spend the riches to make your school, home, library, neighborhood, or park more attractive?
	47.	Develop a class motif of the Thunderbird. Let each child draw his own version; select one to use as a class design.
	48.	Find out what you can about the Hopi Indians' "Kachina Spirits." (Long ago the Hopi Indians believed that in the springtime kachinas descended from the mountains to dance in the corn fields and bring rain. Nowadays the Indians make small wooden kachina dolls to represent the spirit rain

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Concept Number

48. cont. makers.) Cases of the dolls may be borrowed from the Museum of Science and Natural History, Oak Knoll Park.

49. Find out what you can about the Japanese bozu dolls which, in some parts of Japan, are houses to keep the rain away. In other areas of Japan, the children make the dolls and hang them on green willow branches. Compare the kachina dolls with the bozu dolls.

VI. 50. *a. Take the children on a tour of the weather studio at Channel 2. (Phone 647-7777 to make arrangements.)

*b. Invite a speaker from the St. Louis University Meteorology School to speak to your group. Contact the Chairman of the Meteorology Department at 535-3300. Be sure to give the speaker advance guidance in gearing his talk to primary age children.

*c. Field trips to the weather bureau not available, generally below junior high school level according to Mrs. Slaughter at the St. Louis International Airport Weather Station (848-3412). However, she is most cooperative in answering any questions pertaining to weather. Students may write to the National Oceanic and atmosphere Administration, Public Affairs Office, Silver Springs, Maryland 20910, for further information and pamphlets on weather.

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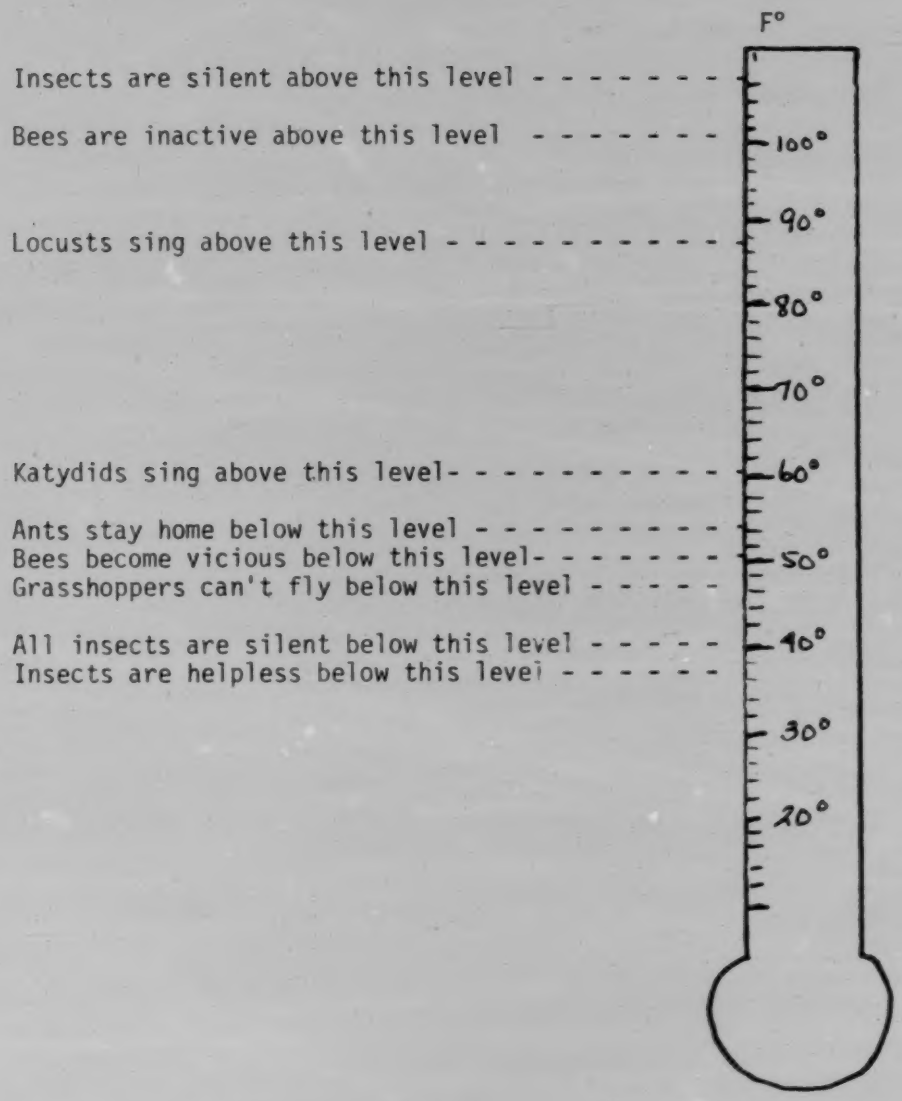
DATA SHEETS

HOW TEMPERATURE AFFECTS THE INSECT WORLD



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CITY-COUNTRY DATA SHEET

NAME _____ DATE _____

LOCATION _____

DESCRIPTION OF CITY: Include descriptions of natural landforms, man-made landforms, weather (clouds, precipitation, humidity, wind, etc.) and control.

DESCRIPTION OF COUNTRY: Include same type of information as above.

DRAWING OF CITY AND COUNTRY: Sketch as many ideas or objects as possible to help you compare and contrast the city and the country.

Compare and contrast the two environments.

What has man done to change the environment? Can you see evidence of control or adaption?

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PART II

AIR, WIND, AND WEATHER

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CONCEPTS
(Part II)

I. Air is a real substance that is necessary for life on earth. Air is everywhere.

II. Wind is air that is moving.

III. Wind carries many tangible and intangible things, such as sounds, odors, dust particles, and pollens.

IV. There are various ways to show wind speed.

V. Nature uses the wind for many things. Man must first harness the wind to put it to his own use.

VI. Weather is a condition of the air. Moisture, temperature, movement, and pressure of the air are conditions that determine the weather.

VII. Safety precautions should be taken during storms.

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BEHAVIORAL OBJECTIVES
(Part II)

Concept Number		
I.	1.	Upon completion of the lesson on air and its properties, seventy-five percent of the students will be able to distinguish living things which require air to survive and nonliving things which do not require air by correctly classifying them in a given set of pictures.
II.	2.	At the end of the lesson on wind, ninety percent of the children will be able to identify the pictures that show movement of air.
III.	3.	Upon completion of the lesson wind, eighty-five percent of the children will be able to choose from a given list those things which are carried by wind under favorable weather conditions.
IV.	4.	After completing the unit on weather, eighty percent of the children will be able to identify pictures of two instruments used to show wind speed.
V.	5.	At the end of the unit on weather, seventy-five percent of the children will be able to distinguish, on a given set of pictures, ways in which the wind is used by nature and by man.
VI.	6.	Upon completion of this unit on weather, seventy-five percent of the children will be able to recognize the conditions that determine weather.
VII.	7.	Upon completion of the lesson on storms, eighty percent of the children will make a list of five safety precautions one should take when a tornado strikes.
VIII.	8.	Upon completion of the lesson on storms, eighty percent of the children will be able to list five rules one should try to follow when a lightning or thunderstorm occurs.

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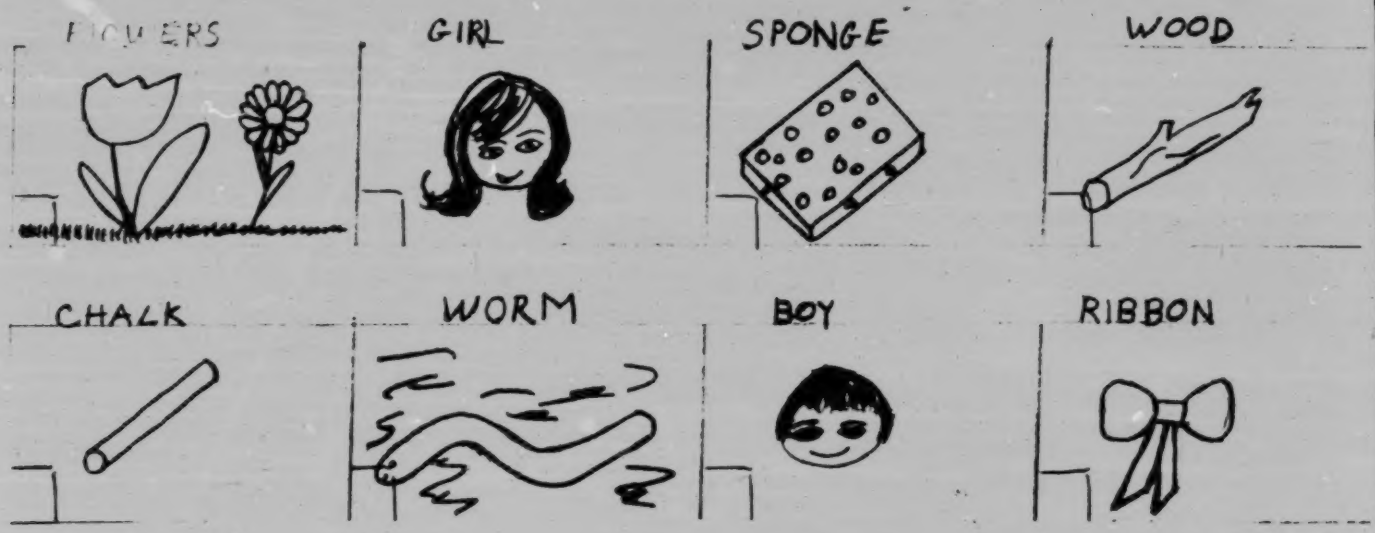
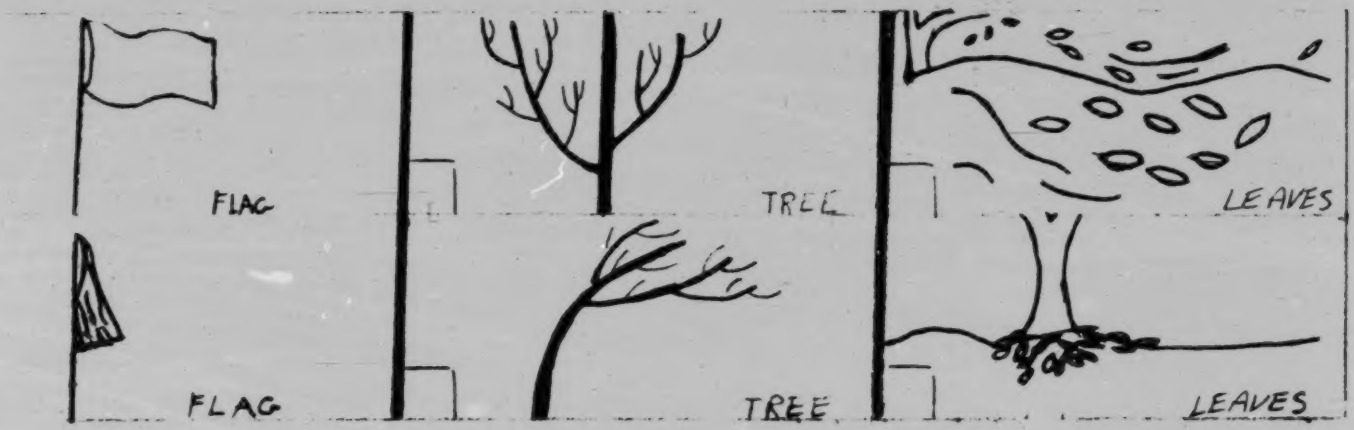
PRE-POST TEST
(Part II)

1. a. Put an X in the boxes that show living things which require air to survive.

   b. Put an O in the boxes that show non-living things.



2. Put an X on the pictures that show what happens when the wind blows.



3. Put a circle around the words that show what the wind can carry during good weather.

CAR HOUSE ODORS

SMOKE DOG

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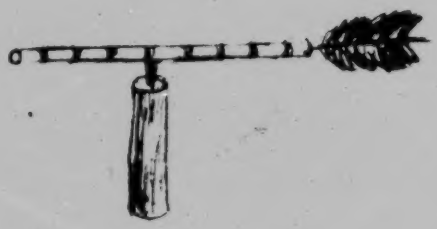
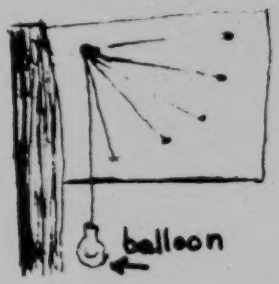
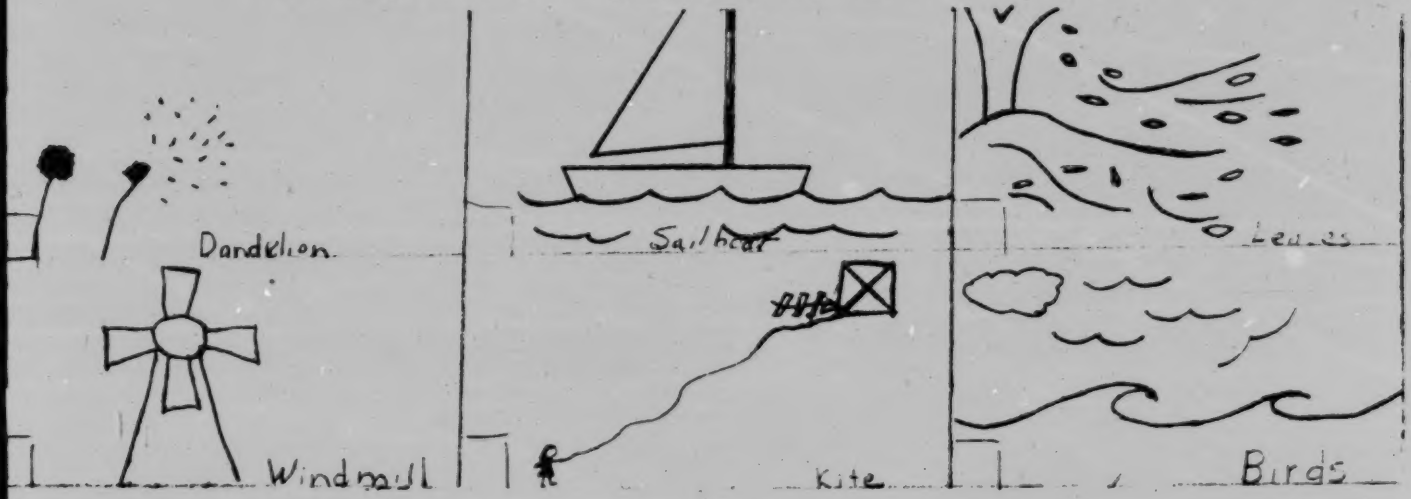
4. Put an X on the pictures which show things that tell how fast the wind is moving





5. Mark the pictures that show how nature uses the wind with an X.
Mark the pictures that show how man uses the wind with an O.



6. Complete the following statement. Moisture, temperature, movement, and pressure of the air are conditions that determine the _____.

7. List five things you should do to keep safe during a tornado.
   a.
   b.
   c.
   d.
   e.

8. List five safety rules you should follow during a lightning storm.
   a.
   b.
   c.
   d.
   e.

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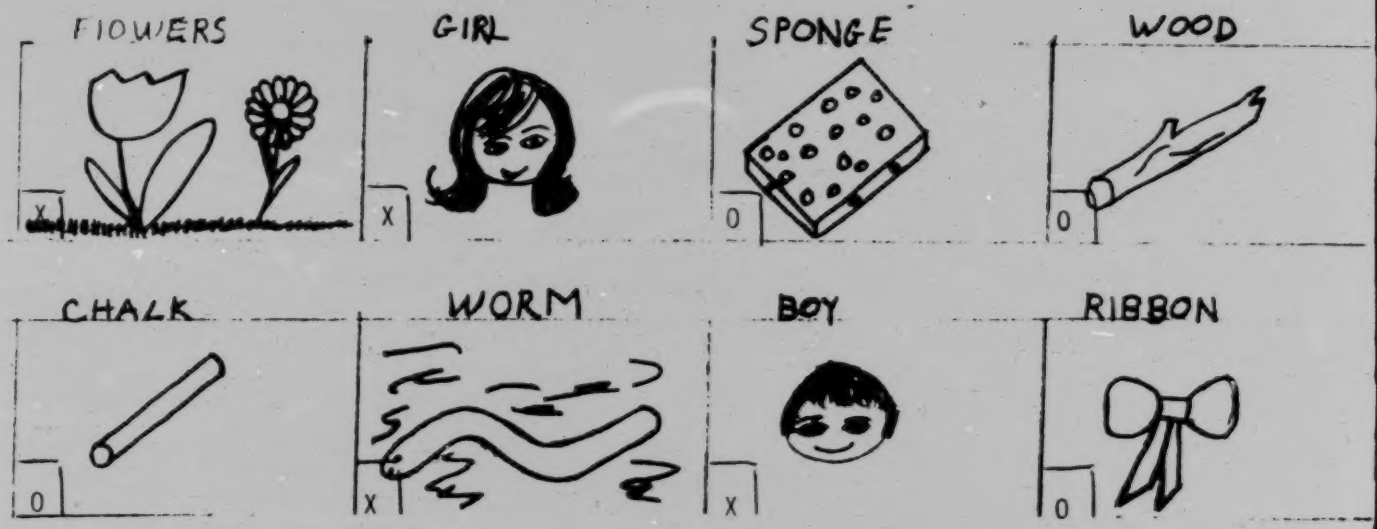
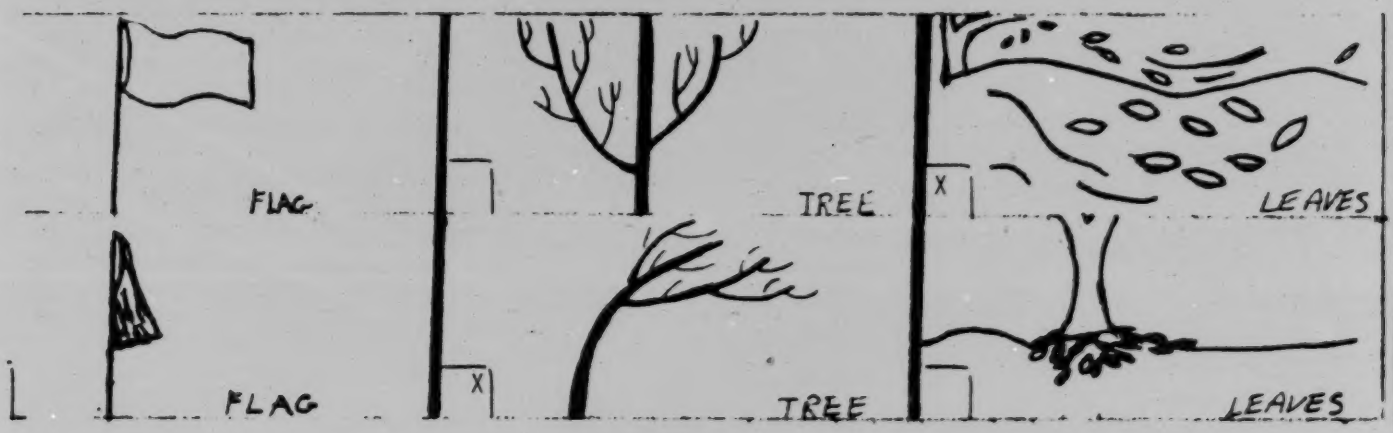
ANSWER SHEET
PRE-POST TEST
(Part II)

1. a. Put an X in the boxes that show living things which require air to survive.

   b. Put an O in the boxes that show non-living things.



2. Put an X on the pictures that show what happens when the wind blows.



3. Put a circle around the words that show what the wind can carry during good weather.

CAR HOUSE ODORS

SMOKE DOG

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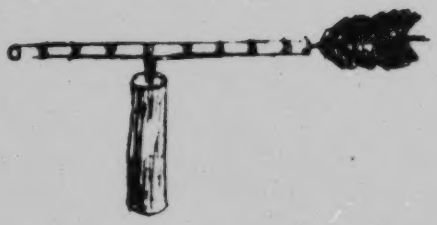
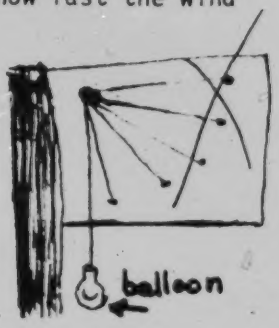
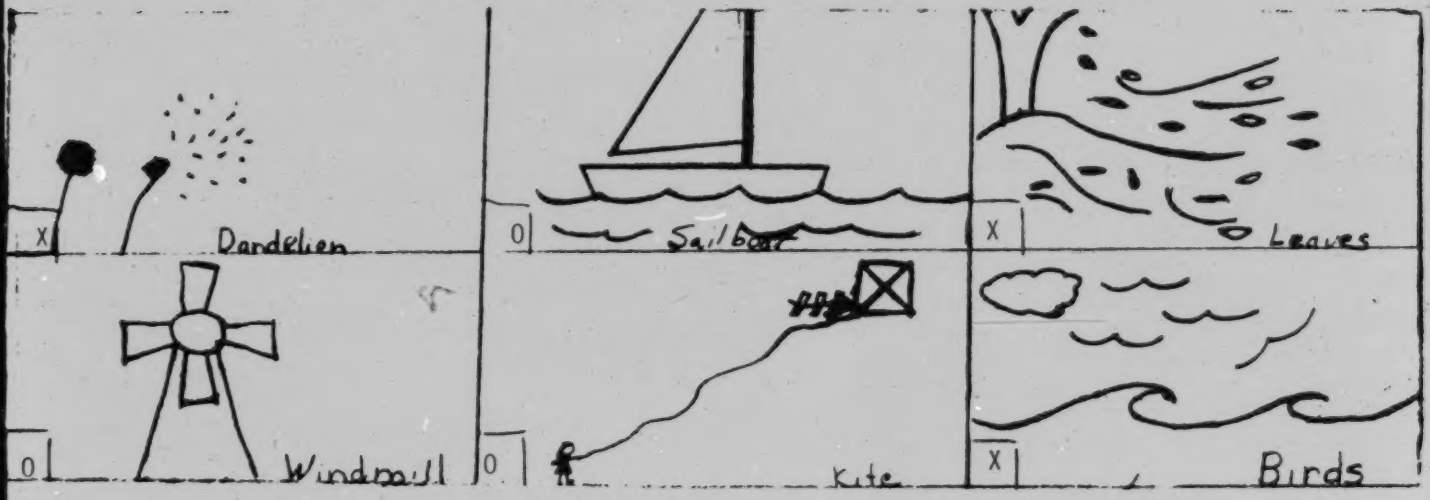
4. Put an X on the pictures which show things that tell how fast the wind is moving





5. Mark the pictures that show how nature uses the wind with an X. Mark the pictures that show how man uses the wind with an O.



6. Complete the following statement. Moisture, temperature, movement, and pressure of the air are conditions that determine the weather.

7. List five things you should do to keep safe during a tornado.
   a. If time permits, go to the nearest cellar, cave, or underground excavation. This underground shelter should have an outlet to equalize the air pressure.
   b. If you are in open country, move at right angles to the tornado's path.
   c. If there is not time to escape, lie down flat in the nearest ditch.
   d. If you are in a city, seek indoor shelter, but stay away from windows.
   e. In a home, the corner of the basement toward the tornado usually offers the greatest safety. If the home has no basement, crouch underneath a piece of heavy furniture.
   f. Standing against the inside wall of an office building offers some protection.
   g. If in school, follow the tornado procedure which the teacher has instructed you.

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8. List five safety rules you should follow during a lightning storm.
   a. If you are swimming, get out of the water immediately.
   b. If you are outside, go indoors.
   c. If a storm is directly overhead, stay away from stoves, telephones, windows, bathtubs and showers.
   d. If you are in a car, stay there. A car is the safest place in which you can be.
   e. Don't stand under a tree. Lightning strikes highest objects.
   f. If you are in a field, lie down in as low a spot as you can. Don't stand and be the highest thing in the field.
   g. Keep away from metal.
   h. Do get under a cliff or ledge.

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BACKGROUND INFORMATION
(Part II)

Concept I

Weather is the condition of the air around us from hour to hour, from day to day. Weather is caused by the moisture in the air, the temperature of the air, the movement of the air, and the pressure of the air.

The earth is covered with a blanket of air about 7000 miles deep, which gradually thins out into space. Air is composed of nitrogen, oxygen, carbon dioxide, and minute amounts of neon, argon, xenon, krypton, helium, hydrogen, and ozone. In addition, air contains water vapor, dust, ash, bacterium, pollen, and pollutants.

The components of the air differ according to various factors; e.g., temperature affects the amount of water vapor the air can hold, dust may be stirred up by winds, and the amount of pollen in the air varies with the seasons.

Air is around us all the time. It is a mixture of colorless, invisible gases which compose the atmosphere. Each of us uses up about 6000 gallons of air a day. It is spread throughout every part of our bodies. We can neither see, smell, nor taste air. Seldom are we aware of the thousands of pounds of air constantly pressing down upon us from above. The reason we do not feel this pressure is that the air inside our bodies is pushing back with the same force.

Warm air rises, and as it rises it is replaced by cooler air. Some surface areas touched by air are lighter in color and do not absorb as many of the sun's rays. Asphalt, for example, is dark, so the air above it is warmer. As warm air rises, cooler air rushes in to take its place; it picks up leaves and papers, whirling them like a top. The greater the differential in temperature, the faster the air moves.

At the surface of the earth, the air molecules are more dense than they are in the higher areas, where they are not pressed together by the weight of the above air. The air also tends to get progressively colder farther away from earth.

When you discover what makes the molecules move, you are beginning to find out about the wind. Wind is air that is moving. Moving air, or wind, carries things along with it; moving air pushes against things; and we can make our own wind by making air move.

Air has many important uses. What would life on earth be like if there were no air? We would not make a fire to cook our meals. Sounds would not reach us. Plants could not grow. There would be no water. Earth's surface would be oceanless. We would have no weather. The sky would be black and there would be no rainbows. We could not live.

Air is useful in other ways. It traps the heat of the sun's rays so that the heat escapes more slowly into space and, at the same time, warms the earth. The moon has no blanket of air about it and therefore suffers from severe temperature changes. Air protects us from temperature extremes

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between night and day, summer and winter.

Air also shelters man from a steady rain of meteors or shooting stars.

Concept II

Wind is a key idea in talking about weather. Without air there can be no weather or wind. We use the word weather to describe how hot or cold, or how wet or dry, the air is. Changes in the air around us and above us cause various kinds of weather. A very simple explanation of weather could be stated in this way: The sea gives us water. The sun gives us heat. Heat makes air and water move.

When air moves we call it wind. An important question which may arise when talking about wind is "Why does the wind blow?" Air circulates because of differences in temperature. (See Air Exchange and Soil and Rock Experiment.) Some areas are lighter and do not absorb as many of the sun's rays. Asphalt is dark, so air above it is warmer. As warm air rises, cool air from a shady spot next to it will rush to take its place. As it rushes in, sometimes it may pick up leaves and papers, and whirl them around like a top. The greater the difference in the temperature, the faster the air moves. This is why we have winds of different speeds. The main concept is that warm air rises, and is replaced by cooler air as it rises.

On shore and off shore breezes can be explained by this concept. Water does not heat as rapidly as land. When warm air over the land rises, cooler air from over the water comes in to take its place. This is called an off shore breeze.

The major air flow over the United States comes from slightly south of west or slightly north of west. Since winds are named according to the direction from which they come, this major air flow is called the prevailing westerlies. Thus, postcards sent up with helium balloons (see activities for this part) will most likely be found to the east, or slightly to the northeast or southeast.

Were it not for the repeated invasions of cold air from the polar easterlies and complications caused by air being forced over mountains, weather in the United States would be relatively stable. However, because of these winds, fair weather and clear skies alternate with periods of steady rain.

Wind carries pollution. Your eyes smart and sting, tears flow, your throat feels scratchy, your voice is raspy, breathing is difficult -- these are all effects caused by air that has become polluted. Air we breathe can become polluted and unclean, and produce definite consequences on man and his environment.

Natural causes of pollution:

1. Dust storms - tiny particles of dirt are thrown up into the air.

2. Forest fires - quantities of smoke and gas are flung into the air.

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3. Animal and plant remains, pollen from living plants - whipped into the air by winds.

Pollution caused by man:

1. Smoke from man-made fires of many types.

2. Industrial smoke stacks which send particles and gases into the air.

3. Industrial smoke - small particles of carbon, soot, and fly ash. When this "smoke fog" blankets an area, it holds unwanted particles and keeps them from escaping into the upper air.

If there were no air, you would be unable to hear any sound. Sound is carried by wind. The wind, blowing through many things, can make a variety of sounds:

through grass -- a whisper
over the top of a forest -- the roar of the surf
through a crack -- a whistling sound
down a chimney -- a moan
in dry leaves -- the crackle of fire
blizzard wind -- a howling sound
hurricane wind -- a screaming sound
tornado wind -- buzzing, then roaring sounds

Sound travels through the air even on a calm day, but the wind can carry sound much farther. It can carry the sound of a train whistle, or a buoy, or a song for long distances. If the wind is blowing the sound in the direction opposite from you, you might not hear it, even if the sound is very nearby.

Smells also travel on the wind. On a spring day a certain breeze might bring the smell of the country into the city. If the wind direction is right you might even smell the cookies being baked in a cookie factory in another town.

Animals depend heavily on smells for their survival. They have a sharply developed sense of smell. They can smell people or other animals from great distances if they are "down wind" of the smell. ("Down wind" means that the wind is blowing toward them.) Smells don't travel "up wind," or against the wind. The same principle applies to sound. A good hearing day is a sign of moisture in the air. Meteorologists know that sounds are carried better by moist air than by dry air.

Both man and nature use the wind for many purposes. Man must first "catch" the wind before he can put it to use for himself. His sailboats use the wind to push their sails. Man needs wind to turn the wheels which pump the water in windmills. A glider then uses the warm, rising air currents to soar and then glides on cooler air currents. Man can ride the wind without wings in blimps and passenger balloons by filling them with gases that are lighter than air.

Children fly kites by using rising wind currents. Farmers use the wind to scatter their seeds. The wind blows pollen from plant to plant. Wind

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makes a difference in the types of plants that grow in any one place; e.g., pines and scrub oaks survive best in areas where there are strong winds. Winds also help to make soil, composed of rock ground to bits by the wind. Man depends on wind to bring him rain.

Nature also uses the wind. Birds glide on the wind. Birds with large wings, such as gulls, are particularly good gliders. Wind carries water. Seeds and pollen ride the wind. The wind serves as a natural way to prune the trees. Continuous or persistent winds dry out the land. This is called "wind erosion," which blows and carries the soil. There is a movement of sand, dust, and soft soil; when a dry surface with no plants to anchor it is reached, a desert is formed.

Concept VII

Storms

Another factor which determines weather is the propensity of cold, heavier air to sink and warm, lighter air to rise. This movement affects air pressure and promotes the occurence of fronts. It also causes breezes and winds and their more violent forms, hurricanes and tornadoes.

1. Tornadoes: Extremely strong winds result in very big storms. There are storms of all shapes and sizes. Tornadoes are characterized by a swirling, upward-moving column of air which whirls in the shape of a funnel. Some people call a tornado a "twister" because it turns like a top. You have probably seen a miniature tornado over a hot surface like asphalt, near a shady wall, swirling the dust and scraps of paper around and around, higher and higher.

   A tornado is one of the most destructive of all storms. The wind moves in a small circle, about 1/8 mile in diameter. It drops down from a cloud and picks up everything in its path. Air pressure is very low at the center of the circle; this is why houses have been known to explode. A "twister's" color varies from gray to black.

   A tornado arises when the conditions that cause thunderstorms are unusually violent. Winds blowing in opposite directions around a strong updraft start a narrow whirl. Centrifugal force throws the air away from the center, leaving a core of low pressure. This low pressure core acts as a powerful vacuum upon everything it passes. Roofs are torn from houses, corks are drawn from bottles, and window panes explode outward. A tornado at sea is called a water sprout.

Tornado Safety Rules

a. If time permits, go to the nearest cellar, cave, or underground excavation, this shelter should have an outlet to equalize the air pressure.

b. If you are in open country, move at right angles to the tornado's path.

c. If there is no time to escape, lie flat in the nearest ditch.

d. If you are in a city, seek shelter indoors but stay away from windows.

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e. In homes, the corner of the basement facing toward the path of the tornado usually offers the greatest safety. If there is no basement, get under a heavy piece of furniture.

f. Standing against the inside wall of an office building offers some protection.

g. If you are in school, follow the steps set forth in the tornado drill.

2. Hurricanes: characterized by great, curcular winds covering an area of 150 to 1000 miles in diameter. Hurricanes are named by using girls' first names, proceding annually in alphabetical order. These storms always begin at sea, starting with very warm air rising from warm ocean waters. All hurricanes are huge, whirling windstorms of enormous speeds rushing in and pushing up a column of warm air. They are accompanied by vast quantities of drenching rain. Hurricanes almost always occur in summer or fall. At the center of each hurricane there is a calm spot, about 15 miles wide where the air is almost dead still. When the eye of a hurricane passes through a town, it sometimes fools people into thinking the storm is over. Actually it is only half over.

3. Monsoons: Monsoon is the Arabic word for season. A monsoon is a storm that lasts for an entire season; a wind that blows steadily for almost six months. A monsoon wind blows onto a continent in summer and away from it in winter. At its beginning, wind storms and rain occurs.

4. Cyclones: Originate when air covering thousands of square miles of land begins to whirl around slowly. There is a storm at the center. A cyclone travels over the ground from west to east. It forms at a front where a warm air mass lies next to a cold air mass. Cold air moves toward the east and warm air moves toward the west. A dent forms and the winds start spinning.

Lightning

Types of lightning:

1. Sheet lightning: Lightning seen far in the distance, or when the flash is hidden from direct view and is seen only as it is reflected from clouds. This blurred lightning is best seen at night. Some people call it heat lightning.

2. Chain or streak lightning: the most common lightning, having straight or branching strokes. Forks and a jagged pattern seem more frequent in the first of a close series of flashes before a good path of charged air is formed.

3. Ball lightning: a flash of lightning so weak that it barely overcomes the resistance of air and moves "in slow motion."

4. Black lightning: black flashes near light ones. They are really flashes which were so bright that the intense light destroyed the sensitive chemicals in the film, producing a black streak in the film.

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Lightning is the same the world over, but it appears in different forms. The position of the observer is a significant factor. The effects of lightning are often strange and sometimes dangerous. Thunder is always caused by lightning. It is agreed that the intense heat of a lightning flash causes thunder. The temperature of a lightning flash is believed to approximate the temperature on the surface of the sun.

Sound waves of thunder are very different from the light waves of a lightning flash. Light waves travel at much greater speeds thus the flash of lightning is seen before the thunder is heard. It takes about five seconds for sound to travel one mile.

Here is a way in which you can count off five seconds. Watching the second hand of a clock, say these words, "One thousand one, one thousand two, one thousand three, one thousand four, one thousand five." See if you can say them in five seconds. The next time you see a flash of lightning, count off five seconds in this way. If five seconds go by until you hear the sound of thunder, the storm is one mile away. (See the dittos on lightning on pages

Most people do not like the noise from thunder, but thunder is not harmful or destructive. Lighting, on the other hand, has many useful aspects. Some of the uses are:

1. The tremendous energy generated by each lightning flash causes some of the nitrogen and oxygen in the air to combine. Nitrogen, a gas that makes up 4/5 of the air, is needed by plants for growth. However, nitrogen is useless unless combined with another chemical. Newly-made nitrogen particles are brought down on the earth with rain and are absorbed by the soil. This is nature's fertilizer; natural, lightning - made fertilizer.

2. During a storm lightning picks up particles of dust, smoke, and gases in the air and electrically charges them in order to draw them out of the atmosphere. Were it not for this, these particles would increase to such an extent that people and animals would be poisoned by the air they breathed.

3. Were if not for lightning, the world's supply of electricity would be neutralized in a short time. Lightning pumps positive charges back into the atmosphere and ionosphere and drops the negative charges to earth.

Lightning can also be extremely harmful to man. Some of the dangerous aspects are:

1. Starting fires in houses.

2. Starting forest fires.

3. Knocking over trees and telephone poles.

4. Killing cows, horses, and other animals in fields.

5. Killing people.

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The dangerous effects of lightning can be minimized by following precautionary rules and practices:

1. If you are swimming, get out of the water immediately.

2. If you are outside, go indoors.

3. If a storm is nearby or directly overhead, stay away from stoves, telephones, windows, bathtubs, and showers.

4. If you are in a car, stay there; a car is the safest spot during a lightning storm.

5. Don't stand under a tree. Lightning strikes highest objects.

6. If you are in a field, lie down in as low a spot as you can. Don't stand and be the highest point in the field.

7. Keep away from metal.

8. Do get under a cliff or ledge.

When an electrical charge in a thunderstorm becomes very big, it can jump to another cloud or to the ground. Lightning may flash from one part of a cloud to another part. As it does so, lightning heats the air through which it passes. The air gets so hot that it explodes. The noise of the explosion is thunder. Thunder and lightning occur simultaneously.

Approximately 1800 thunderstorms crash and flash the word over each year. They are more common in the summer months and happen more frequently in the afternoon because air temperatures are warmer at that time. Strong positive and negative charges are the immediate cause of lightning. A streamer of charged air begins to push from one part of a cloud to another. Once the current starts to flow, we call it lightning.

Lightning ---→ Air ---→ Sound (Thunder)

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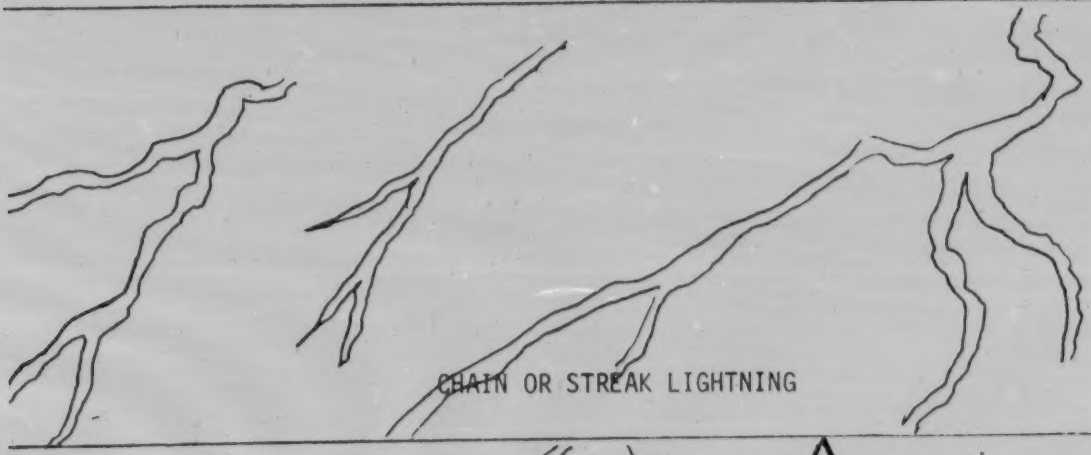
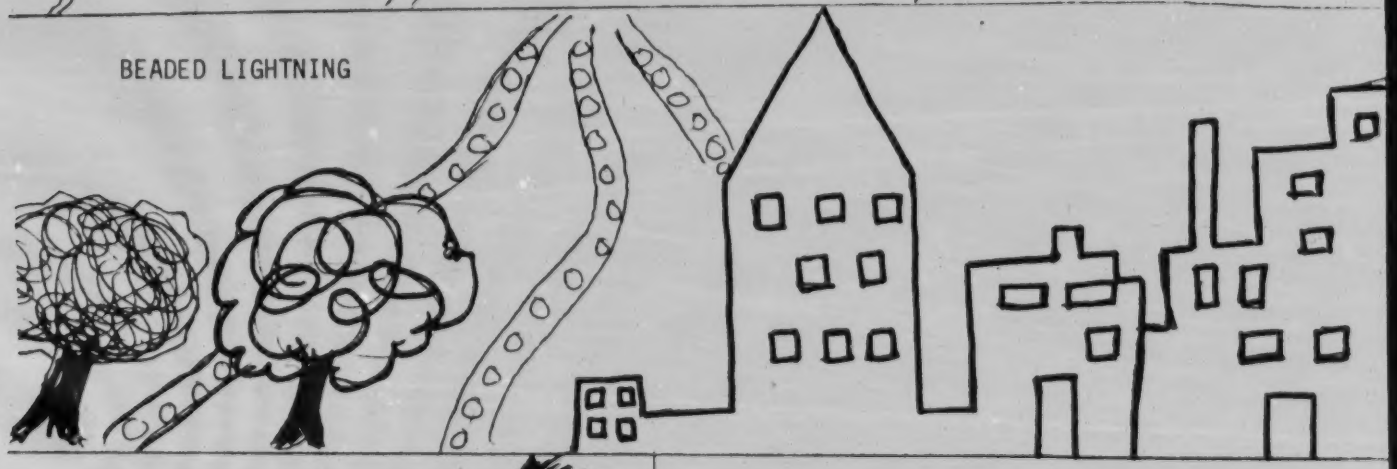
TYPES OF LIGHTNING

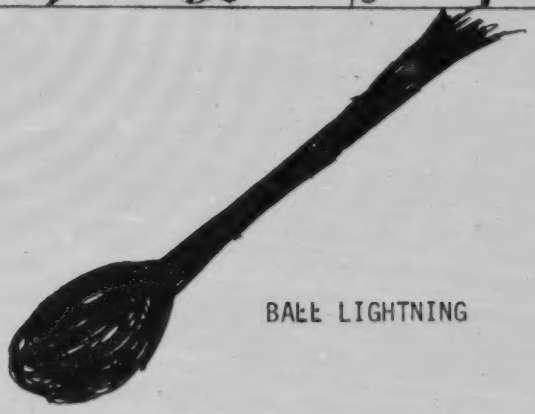
SHEET LIGHTNING



CHAIN OR STREAK LIGHTNING



BEADED LIGHTNING



BALL LIGHTNING

BLACK LIGHTNING

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FLASH
say:
one thousand one or "one chimpansee"
one thousand two or "two chimpansees"
one thousand three or "three chimpansees"
one thousand four or "four chimpansees"
CRASH
one thousand five or "five chimpansees"

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INSTRUCTIONAL SEQUENCE
(Part II)

Concept Number		
I.	1.	To prove that air has weight, weigh an inflated basketball. Deflate the ball and weigh it again. The difference in the weights will be the weight of the air that was inside the ball.
I.	*2.	Can you see air? To find out, take a drinking straw and blow through it. Did you see anything? No. Next, put the end of the straw under water and blow through it as before. Now what did you see? The bubbles are actually air in the form of a bubble. You can see air under certain conditions.
I.	*3.	Hold up a glass and ask whether there is anything inside it. The glass appears to be empty. Fill a sink with water. Turn the glass upside down and push it straight down into the water. Did any water go into the glass? Why not? What was it that kept the water from flowing into the glass? Air occupied the glass. Air takes up space. (This experiment can be used to prove that air is a real substance.)
I.	*4.	Another way to demonstrate that air takes up space is to take the same glass and put some cotton into the water. Did the cotton get wet? What kept it from getting wet? It was the air, taking up space, that prevented the water from getting in and wetting the cotton.
I.	*5.	Do non-living things contain air? To answer this question put a variety of different articles under water; e.g., chalk, wood, sponge, cloth, rope, soil. Record on a piece of paper which items sent up air bubbles, and in what quantities. What do the air bubbles tell us? They show that non-living things contain air. The more air they contain, the greater the number of bubbles that will be sent up.
I.	*6.	Do living things contain air and is air necessary for life? Inhale a breath of air. The teacher will use a tape measure to measure the diameter of a child's chest before and after he inhales. Compare the difference that the breath of air makes. What caused the second measurement to be greater than the first? The air took up space. Now blow into a balloon. What made it get bigger? This demonstrates that living things contain air, too.
I.	*7.	Count the number of seconds you can hold your breath. What things can't you do while you're not breathing? How did you feel when you held your breath? For how long could you hold it? Obviously we need air to carry on the life processes.

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Concept Number		
I.	8.	Do plants need air to live? Plant two baby lima bean seeds, each in its own flowerpot. Water the seeds. Cover a piece of cardboard with clay. Place one of the flowerpots on it and cover the entire plant with a glass jar. The clay ensures that the air will be sealed out; the plant under the jar will receive no air for the entire experiment. Examine both plants daily; compare and record your findings. The plant receiving no air should wither and die. (Advance preparation is necessary for this activity.)
II.	*9.	A simple instrument to make that may be used to measure wind speed is a wind gauge. You will need a long stick, a square piece of cardboard, string, and a balloon. Mark off the cardboard in degrees of ten to make a scale. Attach the string and tie the balloon to the end. Children should take the gauge outside at different points to test wind speed. What made the balloon move? Why does it go higher at different points?
II.	*10.	What makes wind? What is wind? To demonstrate these concepts, make a pinwheel. Obtain a six-inch square of heavy paper. Draw two diagonal lines joining the opposite corners. Put an X in each of the four corners. Now cut along each diagonal line to within an inch of the center. Bend all the corners containing an X (every other corner) so that they lie over the center, and secure them through the center with a pin. Then push the pin into the eraser of a pencil. Hold the pinwheel in front of a fan that is not turned on. Does anything happen? Now turn on the fan and see what happens to the windmill. Why does it turn? The teacher may need to offer some help as to why the fast-moving air made the wind, which in turn made the windmill move. Wind has force; the strength of its force depends on how fast the air molecules are moving. (Save this activity to do outdoors on windy days in place of using a fan.)
II.	*11.	Construct a wind mobile to hang in the classroom. Cover a coat hanger with crepe paper. From the hanger suspend varying lengths of string, tying to them orange juice can lids into which holes have been punched. When the wind blows the lids will touch each other and make a chiming sound. What makes the mobile move? Notice in what directions the strings move. Do they change direction from time to time? Another kind of wind chime can be made in the same way replacing the chime part with firing clay formed in the shape of a disc, which the children can make themselves. A small hole should be left in each disc to attach the string.
II.	*12.	An anemometer is one instrument used by the weather bureau to measure wind speed. A simple anemometer can be made from the bottoms of milk cartons. Mount the milk carton with tacks on a pair of crossed sticks which have been secured with strong plastic tape. A finishing nair driven through the

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Concept Number		
II.	*12. cont.	center acts as pivot and, if oiled, should permit free movement. The nail passes through a Tinkertoy hub, used as a ball bearing, into the top of a short length of wood. The faster the wind speed, the higher the speed of rotation of the cartons. Count the number of times the anemometer turns in one minute. What causes the cups to blow around? It is the wind exerting pressure on the hollow side of the carton. The same force that made the windmill turn makes the anemometer move. Moving air produces wind. (This activity must be done with adult assistance.)
II.	*13.	How do we know from which direction the wind is coming? Construct a wind vane. You will need a straw, a straight pin, a pencil, and a feather. Place the straw on top of the eraser end of the pencil, and use the pin to secure it. Stick the feather in one end of the straw. You will need a compass to find North. The direction in which the narrow, weighted part of the wind vane points indicates the direction from which the wind is coming. Use the wind vane at different points around the school grounds. Note the differences in wind direction in various places.
III.	*14.	Conduct an experiment to emphasize the concept of prevailing westerlies by launching helium filled balloons (minimum of ten). First fill out postcards (example on data sheet following activities for this part). Send off the balloons with the cards enclosed in plastic bags. Mount road maps from a service station on a bulletin board. Place pins to indicate the locations where postcards were returned from. Putting a pin on your own location, extend thin pieces of colorful yarn to the pins designating the sites where the postcards were found.
III.	*15.	Listen to the wind. What does the wind sound like to you? Does it change sounds at different times? The wind can sound like many things, depending upon what it is blowing through. On a windy day, list on the board the various sounds that the wind makes as it blows through grass, over tops of trees, down chimneys, through cracks, between dry leaves, etc. Try to describe the sound it makes by personification: moaning, whispering, whining, etc.
III.	16.	Children should be made aware of odors and how these odors reach their noses. Around lunch time, ask the children if they can tell by using their sense of smell what they are having for lunch that day. Your sense of smell is needed for this experiment too. Turn on the fan and have a child hold an onion in front of it, blowing the odor toward a chosen person. Now have the same person stand behind the fan. This experiment proves that smells blow "down wind" with the wind.

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Concept Number		
III.	17.	The air we breathe is at times loaded with foreign particles - dust, soot, bacteria, spores, pollen -- which we cannot always see. This filled air is commonly known as smog. Smog may be produced by condensation of mosture on dust particles in the air. Blow as much air as possible into a gallon jug. Note that there is little or no vapor in the jar as you let the air escape. Invert the jug, thrust a lighted match into the mouth of the jar, and release the air quickly. A thick smog should be visible. Ask the children what made the smog. What is the smoke resting on? What filled the air?
III.	18.	This experiment can be used to show some of the things carried by that we cannot see. Darken a room. Turn on a flashlight and you will see dust in the beam of light. Ruffle your hair when shines on it and describe what you see. It will probably be small particles of dust which are in the air all the time.
III.	19.	Place a dust particle (or ash, fiber from cloth, pollen, spores, etc.) under a magnifying glass or microscope. See how many the children can identify. What do these specks have to do with weather? Moisture forms on these particles and when they cluster together a cloud is formed. The cloud brings rain.
III.	20.	Scraps of fabric could be used to represent clothes flapping in the wind on a clothes line. Read the poem "The Windy Day" for the setting.
III.	*21.	Try making up your own poems about the wind or wind sounds you might hear. Illustrating the poems would help to get the feeling of the message across.
III.	22.	Pretend you are the wind. Write a story or act out a play showing how important the wind is in bringing us our weather; showing the great force of the wind; showing how we use wind in everyday life; showing what life would be like without any wind. A puppet show may be a good way to dramatize the play.
IV.	23.	After studying the Beaufort Wind Scale, the children should be given practice in trying to read weather maps to see if they really understand the symbols used. The children may try making up their own weather maps, devising their own wind scales and symbols to use.
IV.	*24.	Using only sight observation, the children can practice calculating wind speed simply by observing tree movement. They can make their hypotheses as to what the wind speed is and then use the tree scale to check their guesses. Have the children devise their own wind scales by using different objects outside the classroom (outdoor activity).

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Concept Number		
IV.	*25.	To see if wind speed varies at different points in elevation, take a wind gauge and anemometer to different spots around the school. You may wish to do this daily for a week (same time - same places) just to see what differences do occur. This activity will provide practice in reading the instruments also. Data should be recorded. Try to account for the differences in wind speed. You may need to go back to a discussion on what makes wind move and temperature differences.
V.	*26.	To show how man makes good use of the wind, construct sailboats. A simple boat can be made by taking a piece of wood and driving a nail up through the bottom. Make a paper sail in the shape of a triangle and slip it through the nail by two holes at the top and bottom. Children can decorate the sails using paint or crayons. Sail the boats on a nearby pond, or fill a sink with water and use a fan to create your own wind. What makes the boats move? This activity illustrates the principle that moving air presses against any object in its path. How fast the wind is moving and in what direction can also be determined.
V.	*27.	To demonstrate the effect that moving air has on an object, use a pinwheel. Put the pinwheel on top of a milk carton or paper cone as a way of making a simple windmill. How does a windmill work? What does it use as its source of power? Talk about how man uses the wind to turn windmills. The windmill, in turn, powers the pump that brings water up from the well.
V.	*28.	Some of the children may want to make their own kites. These can be very colorful and can demonstrate the effect of wind on an object in its path. On a windy day, the kite may whip around in all directions. On a very calm, seemingly less windy day, the children may experience trouble getting their kites up in the air.
V.	*29.	Take the children on a tour around the school to look for evidences of wind erosion. Look for bare spots with no vegetation. Why are such spots more susceptible to wind erosion? How can wind speed up the weathering process? Is this helpful to man? Sandpaper different kinds of rock to gain a concept of wind erosion. Lead the children to generalize that it is not moving air by itself that does the wearing, but rather what the moving air carries in the way of dust and grit. Examine the trees to see the pruning effect of the wind on them; some may be twisted, leaning. What speeds the falling of leaves from the trees in fall?
V.	*30.	To demonstrate the effect of wind erosion, fill two shallow boxes with soil; cover one with grassy sod. Using an extension corn, place both boxes outdoors in front of an electric fan. Note how wind moves soil from the unsedded box. What caused

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Concept Number		
V.	*30. cont.	the soil to move? How can the process be slowed down?
V.	*31.	Look for grotesque rock formations, or for pictures of some of the rock formations in the desert. What do you think caused the unusual formations? It is believed that they were carved by the abrasive force of wind-driven sand.
VI.	32.	Study an airplane to see how it is designed. Make an airplane from paper or balsam wood. Why is an airplane constructed in a streamlined shape? What purpose do the wings serve on a plane? The wings of a plane are curved so that when air streams move over the wing, the same lifting effect is produced on the wing. Were it not for the sun, the air would not be heated; part of the air must be heated to make it flow and circle around. Heat and air working together make the winds of the world.
VI.	33.	To study how moving air behaves, obtain an electric fan and hold a narrow strip of paper in front of the fan and then behind it. Held in front, the paper strip blows away from the fan because the whirling blades are moving air with high pressure. Held behind of the fan, the paper bends toward the blades, indicating a low pressure area. The blades push the air in front of the fan away, creating a partial vacuum behind the fan. A fresh supply of air is then pushed into this low pressure area. When air moves rapidly, air pressure is affected. A fast-moving air stream creates low air pressure on one side.
VI.	34.	Study the winds and weather in your own room. Talk about the temperature in your bedroom or observe the classroom temperature when the children frist come in the morning. Notice that early on a cold winter morning, the classroom is cold. The heater will soon get hot as the teacher turns it on. It heats the air right next to it. Cold air pushes the light, warm air up and across the ceiling toward the opposite side of the room. More cold air sinks down and more warm air rises. This movement of air <u>up</u>, <u>across</u>, <u>down</u>, and <u>back</u> is a small-sized wind. Open the windows top and bottom; this allows cool, fresh air to come in through the bottom opening and push out the warm, stale air through the top. A combination of <u>indoor</u> and <u>outdoor</u> wind is created. Study the diagram on air circulation. Fasten paper strips to the top of a window. Watch the direction in which air moves the paper strips. Why do you think the strips at the top move out as warm air is pushed out? Why would strips placed at the bottom move in as cold air rushes in? Does cold air move? Where is the warmest part of the room? Answers to these questions help to explain how winds move and how they bring weather with them.

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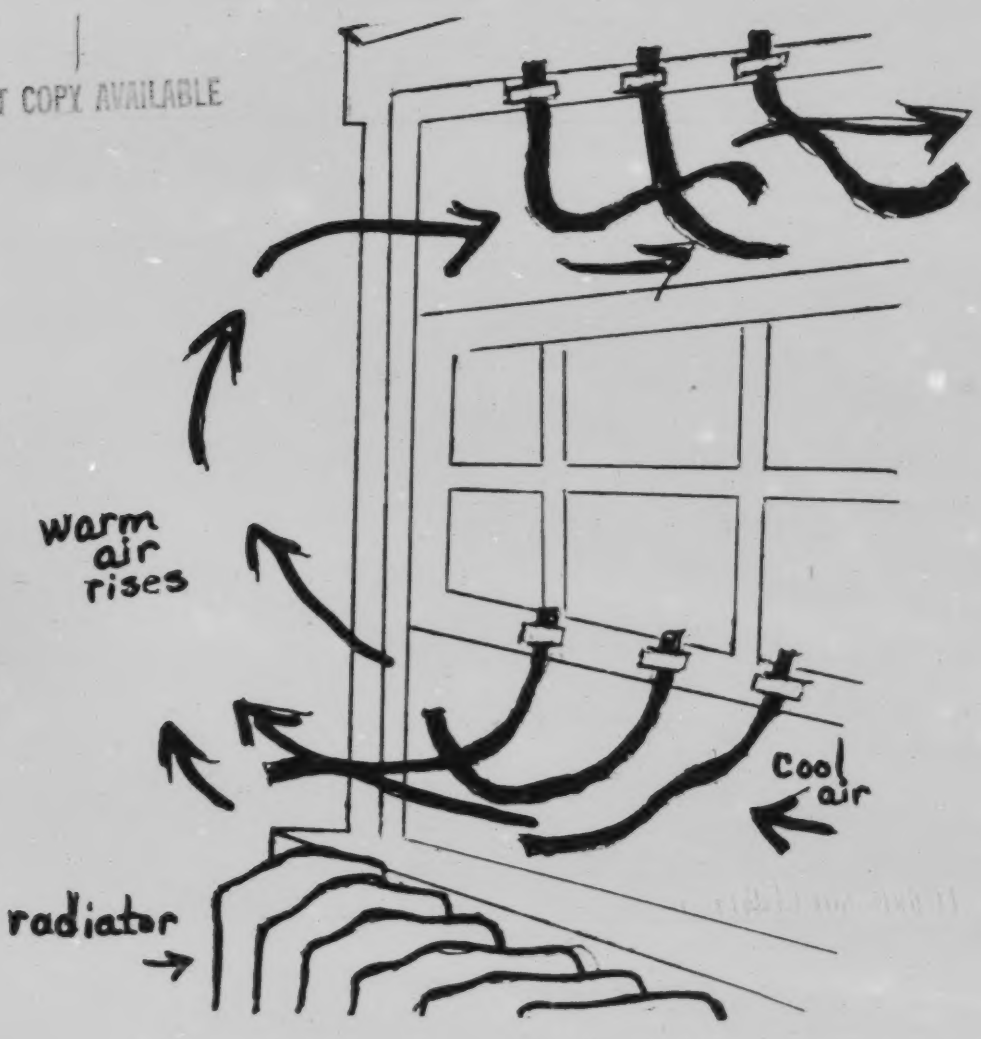

Concept Number

VI. 35. To show that warm air rises, snap a balloon over the neck of an empty soda bottle (before you take it into be recycled). The balloon will hang limp. Then place the bottle in a bowl of hot water. The balloon will begin to fill out. You might also want to transfer the bottle into a bowl of cold water. Can you think of an explanation for what you see?

VI. 36. To demonstrate that hot air rises, let an electric light bulb heat up a few minutes. Sprinkle a tiny amount of talcum or corn starch into the air a few inches above the bulb. Why do the particles rise into the air? How is this like a column on smoke rising? Turn off the bulb. What happens?

VI. 37. To show that air expands when heated (the molecules begin move faster and bump against each other more), measure around the largest part of an inflated balloon with a tape measure or a string. Then put the balloon out in the bright sun. After a few minutes, measure the balloon again. Where did the extra air come from? Transfer the balloon to a cool place. Measure.

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Concept Number		
VII.	38.	What causes lightning? To show that lightning is the same kind of electricity that gives you a shock when you shuffle your feet over a carpet or touch something made of metal, try making your own lightning. You must do this experiment in a completely dark room. Use two balloons shaped like sausages. Blow them up and knot the ends. Rub both balloons back and forth against your dress or shirt at the same time. Then bring them together so that they almost touch. You will see small flashes of light. This is really the electricity jumping between the balloons. You will hear a faint crackle.
VII.	*39.	Next time there is a thunderstorm, find out how far away it is. Count the seconds between the flash of lightning and the thunder.
VII.	40.	Call Mrs. Slaughter at St. Louis International Airport Weather Station (848-3412) for pamphlets on storms and tornadoes.

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DATA SHEET

I am a student in the _____ grade at _____ School. This postcard was attached to a helium balloon to conduct a weather experiment. Please fill out the information below and mail the postcard back to me.

Thank you,

Yours truly,

Student's name

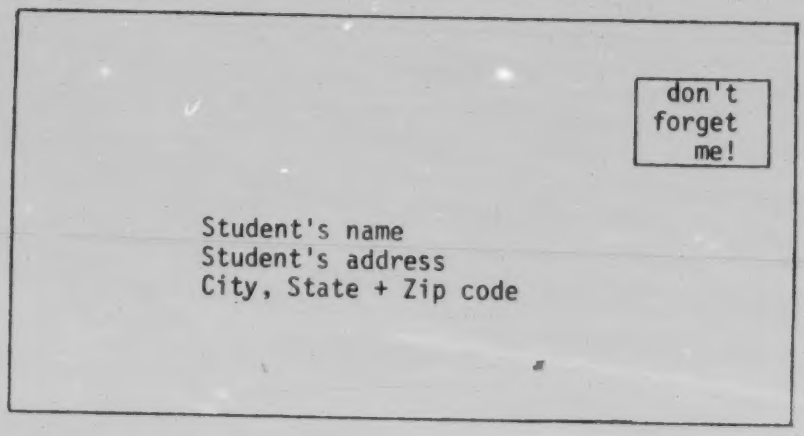
Date _____

Place Found _____

Weather Conditions _____

Name _____

Sample postcard to be filled out by student at school, using pencil, before going to the site.



This side of the postcard must have a stamp and must contain the student's own name and adress.

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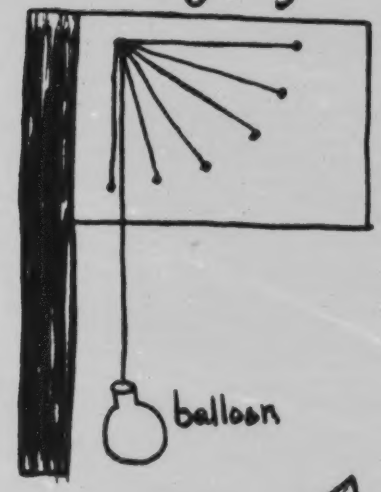
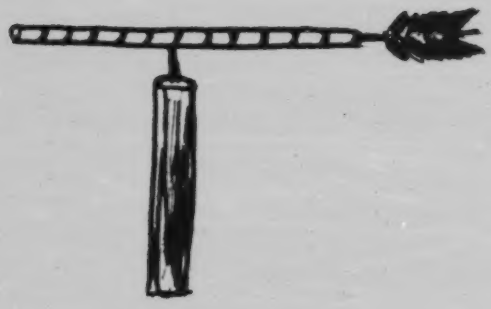
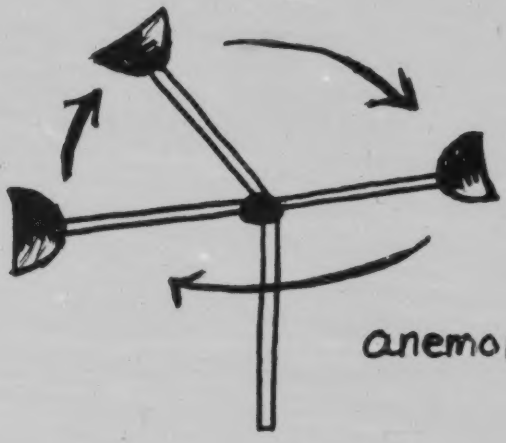
wind gauge



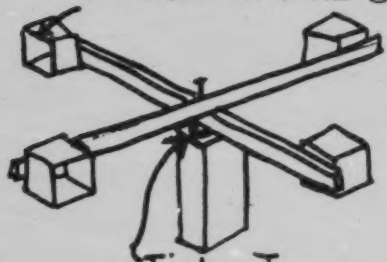
wind vane

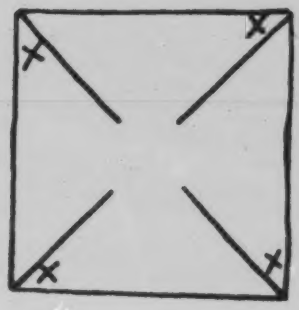




anemometers

bottom of milk carton





pinwheel

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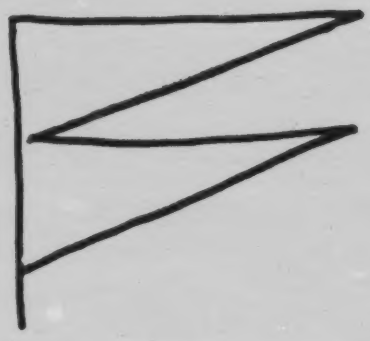
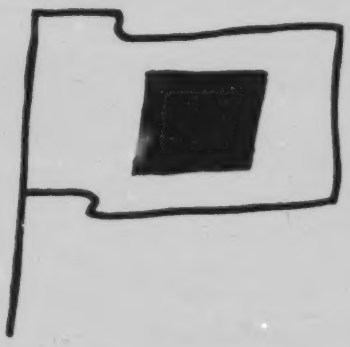
SIGNAL FLAGS FLYING IN HARBORS AND AT COAST GUARD STATIONS WARN OF STRONG WINDS

Color all flags red.

Small craft warning. Winds up to 38 miles per hour are forecast.



Gale warning. Winds from 39-54 miles per hour are forecast.



Full gale warning. Winds from 55-73 miles per hour are forecast.

Hurricane warning. Winds of 75 miles per hour or over are forecast.

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TREES SHOW DIFFERENT KINDS OF WINDS:

If the:	Miles per hour	Kind of Wind
Leaves don't move	0	Calm breeze
Leaves rustle	4 - 7	Light breeze
Leaves and twigs move	8 -12	Gentle breeze
Small branches sway	13 -18	Moderate breeze
Small trees sway	19 -24	Fresh breeze
Large branches sway	25 -31	Strong breeze
Whole tree sways	32 -38	Moderate gale
Twigs break off	39 -46	Fresh gale

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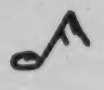
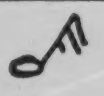
THE BEAUFORT WIND SCALE

Scale Number	Wind Description	M.P.H.	Wind Effect	Beaufort Symbol Used On Weather Maps
0	Calm	0 - 1	Smoke goes straight up	
1	Light air	2 - 3	Smoke drifts in wind direction	
2	Slight breeze	4 - 7	Weathervanes turn, flags flutter, leaves move	
3	Gentle breeze	8 -12	Flags blow out, small branches move	
4	Moderate breeze	13 -18	Dust and papers blow around	
5	Fresh breeze	19 -24	Small trees bend, whitecaps on water	
6	Strong breeze (or wind)	25 -31	Large branches move, telephone wires whistle, umbrellas turn inside out, waves get big, whitecaps foam.	
7	Moderate gale (or high wind)	32 -38	Whole trees move; one must lean against the wind to walk	
8	Fresh gale	39 -46	Small branches break off trees	
9	Strong gale	47 -54	Signs and TV antennas may blow dowy, shingles blow off, awnings rip	

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THE BEAUFORT WIND SCALE

Scale Number	Wind Description	M.P.H.	Wind Effect	Beaufort Symbol Used on Weather Maps
10	Whole gale	55 -63	Trees fall; wires and light structures torn down	
11	Storm	64 -75	Widespread damage	
12	Hurricane	76 - over	Disaster; area is devastated	

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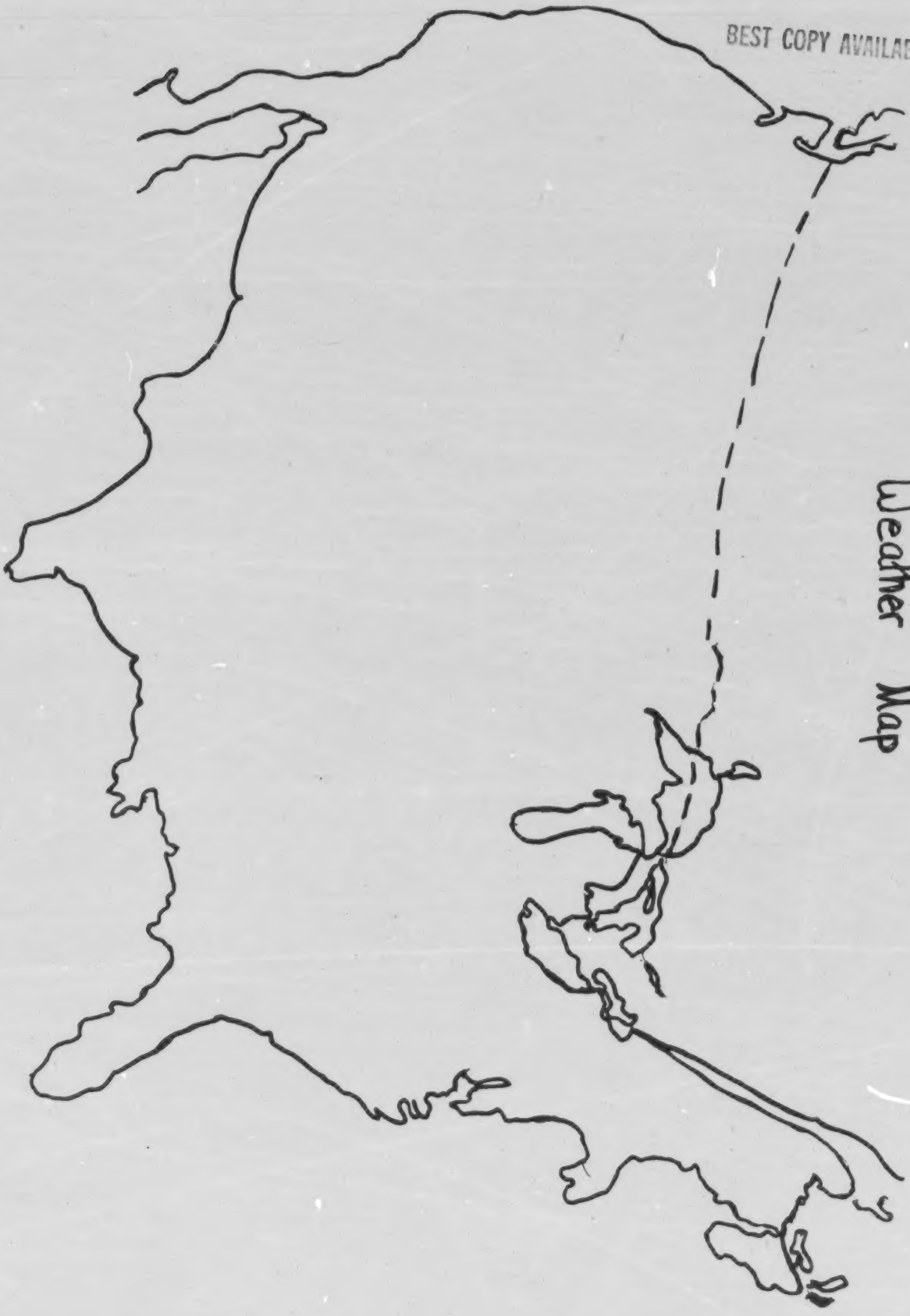

Weather Map

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PART III

HUMIDITY AND CLOUDS

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CONCEPTS
(Part III)

I. Amounts of humidity in the air vary.

II. A cloud is formed by water droplets collecting on dust particles.

III. There are various types of clouds, each having distinct characteristics.

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BEHAVIORAL OBJECTIVES
(Part III)

Concept Number		
I.	1.	At the end of this unit, seventy-five percent of the students will be able to recognize that warm air holds more moisture than cold air.
II.	2.	Upon completion of this unit, seventy-five percent of the students will be able to state in writing that clouds are composed of water collecting on dust particles.
III.	3.	After completing the study of clouds, eighty percent of the students will be able to recognize three cloud types, cirrus, cumulus, stratus, and write at least one characteristic of each type.

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PRE-POST TEST
(Part III)

1. If you could walk inside of a cloud and see the two most important things that form a cloud, what would you see?

   a. _____ b. _____

2. At which temperature can the air hold more moisture? Circle the correct response.

   20° 60° 80°

3. Label each cloud type and list one characteristic of each. Characteristics may be shape, size, color, height, formation, etc.

(a)

(b)

(c)

ANSWER SHEET
PRE-POST TEST
(Part III)

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1. If you could walk inside of a cloud and see the two most important things that form a cloud, what would you see?

   a. dust b. water vapor

2. At which temperature can the air hold more moisture? Circle the correct response.

   20° 60° 80°

3. Label each cloud type and list one characteristic of each. Characteristics may be shape, size, color, height, formation, etc.

(a) (b) (c)

   a. cirrus - highest clouds; composed of ice crystals; wispy, feathery.

   b. cumulus - round, cotton-puff shape.

   c. stratus - flat; low hanging; gray.

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BACKGROUND INFORMATION
(Part III)

Concept I

Humidity

Water is always present in the air. Seventy percent of the earth is covered with water. Water evaporates from the earth into the air. In the air, water exists in three states; solid, liquid, and invisible vapor.

The amount of water vapor in the air is called the humidity. "Relative humidity" is the amount of vapor the air is holding expressed as a percentage of the amount the air could hold at a particular temperature. Warm air can hold more water than cold. When air with a given amount of water vapor cools, its relative humidity goes up; when the air is warmed, its relative humidity drops.

As the table below illustrates, air at 86° Fahrenheit is "saturated" when it holds 30.4 grams of water vapor per cubic meter. In other words, it has a relative humidity of 100%; it has reached its dew point the temperature which dew starts to form or vapor to condense into liquid. But air at 68° is saturated when it holds only 17.3 grams per cubic meter. That's a difference of 13.1 grams per cubic meter. So every cubic meter of air saturated at 86° that is cooled to 68° will lose 13.1 grams of water vapor as cloud droplets which, if conditions are right, will fall as rain or snow.

TEMPERATURE	RELATIVE HUMIDITY					
86°F	16%	24%	31%	45%	57%	100%
68°F	28%	42%	54%	79%	100%	
61°F	36%	53%	69%	100%		
50°F	52%	77%	100%			
43°F	67%	100%		PRECIPITATION		
32°F	100%					
	4.85	7.27	9.41	13.65	17.31	30.4

GRAMS OF WATER VAPOR PER CUBIC METER

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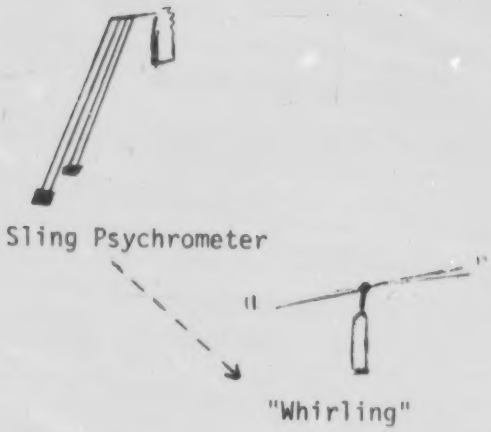
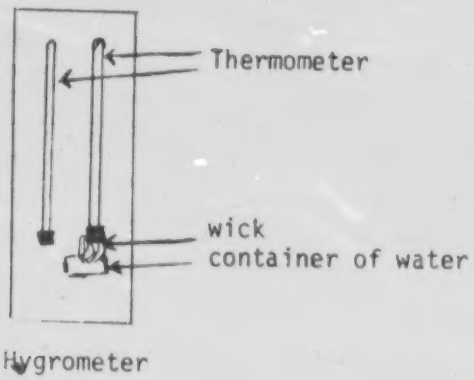
The Psychrometer

Relative humidity is measured with a sling psychrometer, consisting of two thermometers. One is a regular mercury thermometer. The other, a wet bulb thermometer, differs only in that it has a muslin wick over its bulb. The end of this wet bulb thermometer is dipped into water before the reading is taken. These thermometers are whirled before the psychrometer is read. Evaporation from the muslin wick lowers the temperature of the wet bulb thermometer. In dry air, there is more evaporation and therefore more cooling than in moist air; hence the difference in temperatures shown by the two thermometers will be greater. The differences at certain temperatures will indicate the relative humidity. (See chart, Student Data Sheet #1).

The Hygrometer

The hygrometer will also provide a reading for relative humidity. This instrument has a constantly wet wick on the wet bulb thermometer. The hygrometer stays in the weather station and, once set up, need never be touched except to refill the water every few days.

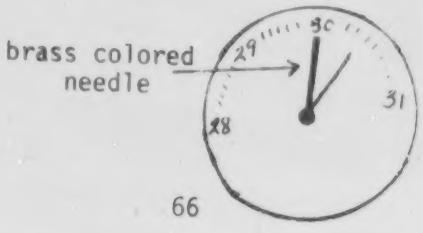




The Barometer

A good barometer and the table provided in the student data sheets will help you make reasonably good weather forecasts.

Calibrate your barometer to sea-level pressure by checking with your local weather station or airport. This is done with the brass-colored needle on your barometer. The other needle indicates the air pressure changes in inches.



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A rapid rise or fall in barometric pressure is 0.05 to 0.09 inches in less than three hours. Be sure to keep accurate records at regular intervals in your weather station. (See Student Data Sheets #3 and #4).

The Maximum and Minimum Thermometer

This instrument is used in deriving the maximum and minimum temperatures for any 24-hour period.

Twenty-four hours before you want to read the maximum and minimum temperatures, you must take the attached magnet and slide the metal indicators all the way down. During the warmest period of the day, the mercury on the left side of the thermometer will rise, pushing the metal indicator up to the highest temperature reached, where the indicator will remain. During the night or the coolest period, the temperature will drop, causing the mercury on the right side of the thermometer to go up, pushing the metal indicator up where it will stay. To derive these two temperatures read the lower edges of the metal indicators; on the left for the maximum and on the right for the minimum.

Concept II

Clouds

Clouds are composed of water and dust particles. When clouds grow and become too heavy to hold the precipitation inside them, it will fall in the form of rain, hail, sleet, or snow.

Condensation takes place when warm moisture evaporates and rises. In rising the water vapor cools and condenses, forming tiny droplets which collect on dust particles, which form a cloud. The greater the amount of water and dust particles in the air, the more cloudy the sky. The water or hydrological cycle is the basis for the continuous process of cloud formation and precipitation. The most important operations in the water cycle are evaporation and precipitation. The principle of evaporation states that when moist air is heated it expands, becomes lighter, and rises. As the air rises it cools 5 1/2° every 1000 feet. When the air cools it becomes heavier and condenses into liquid droplets which light on dust particles, thus forming a cloud. When the water in the cloud becomes too heavy it falls and becomes absorbed into the ground. Following absorption comes evaporation, which continues the cycle.

Some clouds take many days to grow and reach their saturation stage, but not all clouds produce precipitation. At times clouds may be unable to precipitate and must be aided by man when he needs rain. Man provides more particles on which water droplets may land to form a heavier cloud. Two current methods are the use of silver iodide and dry ice. The end result of rainfall depends on the amount of water held within the cloud.

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Concept III

Clouds are nature's way of telling a story by drawing pictures in the sky. Man may lie on a hill or walk outside and watch the constantly changing colors, shapes, and forms move across the sky. Most clouds are white or shades of gray and blue which may be changed by shadows. Atmospheric changes cause color changes: thunderstorm clouds take on shades of bluish black, rainy skies are composed of dense grays, high ice crystal clouds are white as are puffy fair weather clouds and sunsets and sunrises may vary in shades of red, yellow, and orange. Shapes, as well as colors, change with different types of clouds. Clouds may be drifting rolls, piles of ships, domes, floating veils, willow streaks, low hanging blankets, etc. The variance in shape, color, height, size, composition, etc. has lent an easy way for naming clouds. At the beginning of the 19th century Luke Howard, an Englishman, named four basic cloud types: Cirrus, Cumulus, Stratus, and Nimbus in Latin. From the basic cloud types other detailed forms are named. Authorities sometimes differ on how many cloud types there actually are.

Cumulus clouds appear with the sun and ride on top of warm air currents, which signify fair weather. These clouds are known as "woolpacks" or heaps from their billowy, round, cotton-puff shape. The bases, 1,600 feet above the ground, are flat and gray, whereas the white tops climb and swell up to a height of three or four miles. When a height of three to four miles is reached, the cumulus cloud may turn into a thunderhead and bring rain, hail, thunder, and lightning. Cumulus clouds appear more frequently in the summer, forming in the morning and vanishing by evening. Imaginations may take over when watching cumulus clouds change shapes, forms, and movements.

Stratus clouds are flat, low-hanging, uniform layers of gray sheets or blankets. These clouds are very dull and uninteresting in appearance. Stratus clouds usually forecast bad weather. Actually they are layers of fog 50 to 100 feet thick, at a height of 1000 to 6000 feet. Stratus clouds are formed as a result of calm air cooling.

Nimbus clouds are swift, dark, threatening storm clouds. They form at low altitudes, cover a wide area, and have no definite shape. Nimbus clouds are classified as the carriers of water or some form of precipitation. All forms of nimbus clouds mean storms.

Cirrus clouds are the highest clouds, forming at levels of 20,000 feet and above. At this altitude the temperature is below freezing; thus they are composed of ice crystals. When looking at cirrus clouds, it appears as though an artist took his brush and painted thin, wispy, feathery streaks, curls, and ringlets across the sky. Although cirrus are high clouds, which mean fair weather with little moisture, they usually forecast winds and storm warnings. Cirrus clouds are also known as "mare's tail," "witch's broom," "cat's tail," and "sea grass."

Cirrocumulus clouds form at 10,000 to 30,000 feet above ground level. These clouds are small and fluffy with relatively little shading. Cirrocumulus clouds are known as a "mackerel sky" because their arrangement is similar to fish scales. Another picture the cirrocumulus clouds take on is similar to ripples of blown sand. Actually the cirrocumulus clouds are more of a forewarning to low, dense, stratus and nimbus clouds of rain and bad weather.

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Cirrostratus clouds are large halos, drapes, thin sheets, or patches of veils. Often cirrostratus clouds form the halo around the moon. Their height is from 20,000 to 25,000 feet above the ground. Usually rain or snow may be expected within 24 to 36 hours. However, cirrostratus clouds alone will not bring rain.

Altocumulus are classified in accordance with the height of cumulus clouds. These clouds form at levels from 6,000 to 20,000 feet in the sky. Their height varies with their appearance: gray or white bands, patches, or layers of puffy rolls with thin edges. (Similar to stratocumulus).

Altostratus clouds are high, dense, gray or blue sheets or veils. They appear fibrous or striped and seem frosty when covering the sun. Altostratus form at levels of 6,500 to 20,000 feet above the ground.

Stratocumulus clouds are close together, irregular patches or rounded packs of gray and white. An unbroken ceiling is formed when puffy layers touch. The bases are never higher than 6,500 feet. Stratocumulus alone do not mean rain, but may change to nimbostratus. They appear before an approaching shower or after a shower in a clearing sky.

Nimbostratus clouds form at surface level and up to 6,500 feet. These are actually dark, wet stratus clouds in the state of rain production.

Cumulonimbus clouds form at heights ranging from 16,000 to 20,000 feet above ground level. These clouds originate from cumulus clouds which have towered and swelled into massive thunderheads. A fully developed cumulonimbus cloud has a thin, anvil-shaped top composed of ice crystals. The top is formed by high ups and downs of the wind currents. Summer thunderstorms from cumulonimbus clouds bring rain, hail, lightning, and thunder.

Fog is really a cloud of stratus form which spreads out and touches the ground. Fog, when heavy and dense, is often compared to pea soup. Smog is a form of fog and is usually associated with industrial areas. Mixtures of fog, smoke, soot, exhausts, gases, etc. cause air pollution which plague industrial cities.

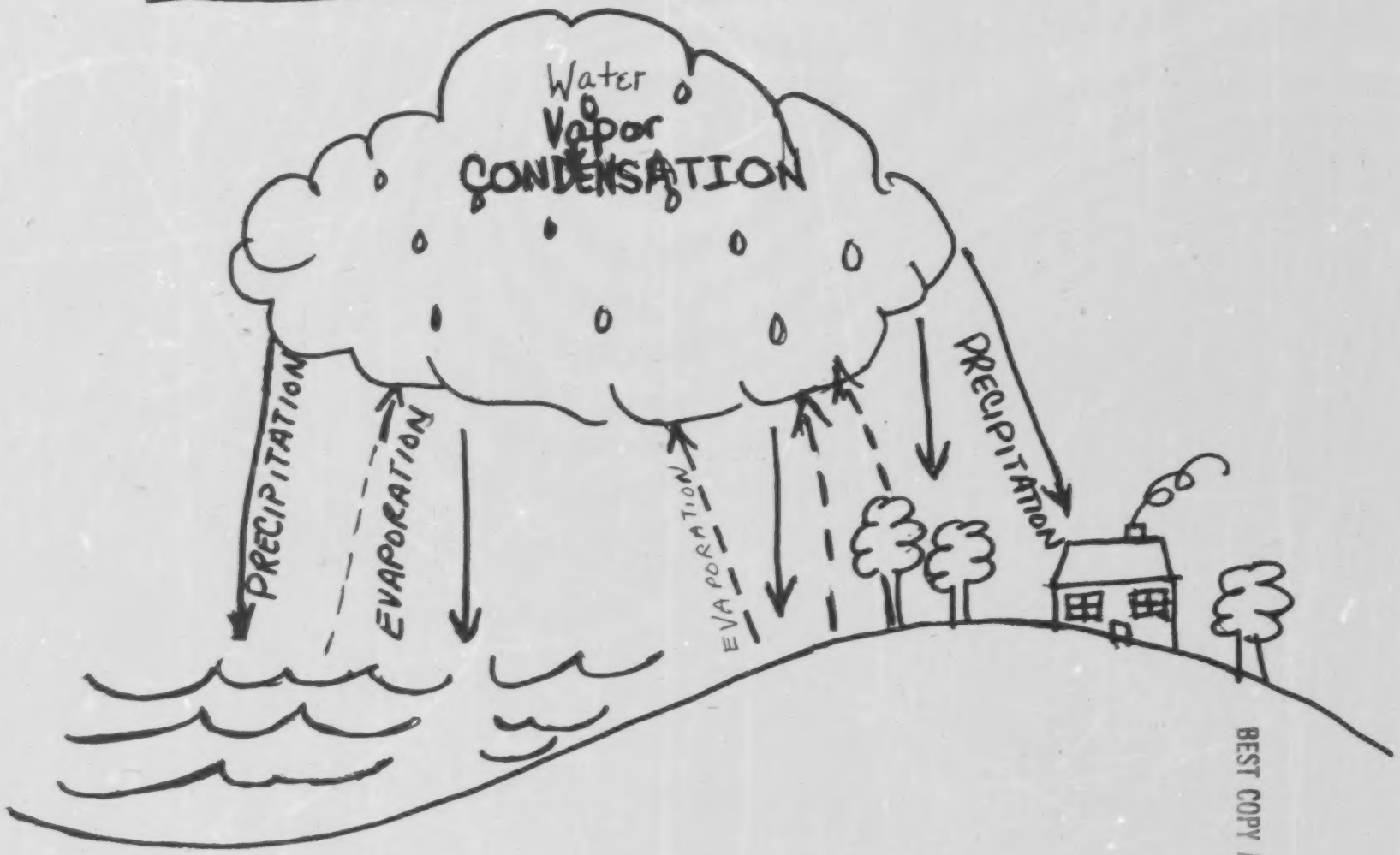
While clouds are classified by many methods using shape, height, size, and prediction, they are difficult for the novice to distinguish. In weather forecasting the amount of cloudiness is measured and related to the public. To determine the amount of cloudiness the number of tenths of covered sky is measured and put into fractional form. A clear sky is zero tenths, overcast is ten tenths, and partly cloudy sky is five tenths. One should not measure by observing the horizon because it appears more cloudy.

VOCABULARY

1. Condensation - the process of changing from a gas or vapor to a liquid. When vapor is cooled it contracts and changes form.

2. Evaporation - the process of changing from a liquid to vapor caused by expansion; the removal of moisture.

HYDROLOGICAL CYCLE



1) ⟶ precipitation from clouds
2) ⟷ evaporation from water and land
3) transpiration from plants
4) condensation of vapor to liquid form

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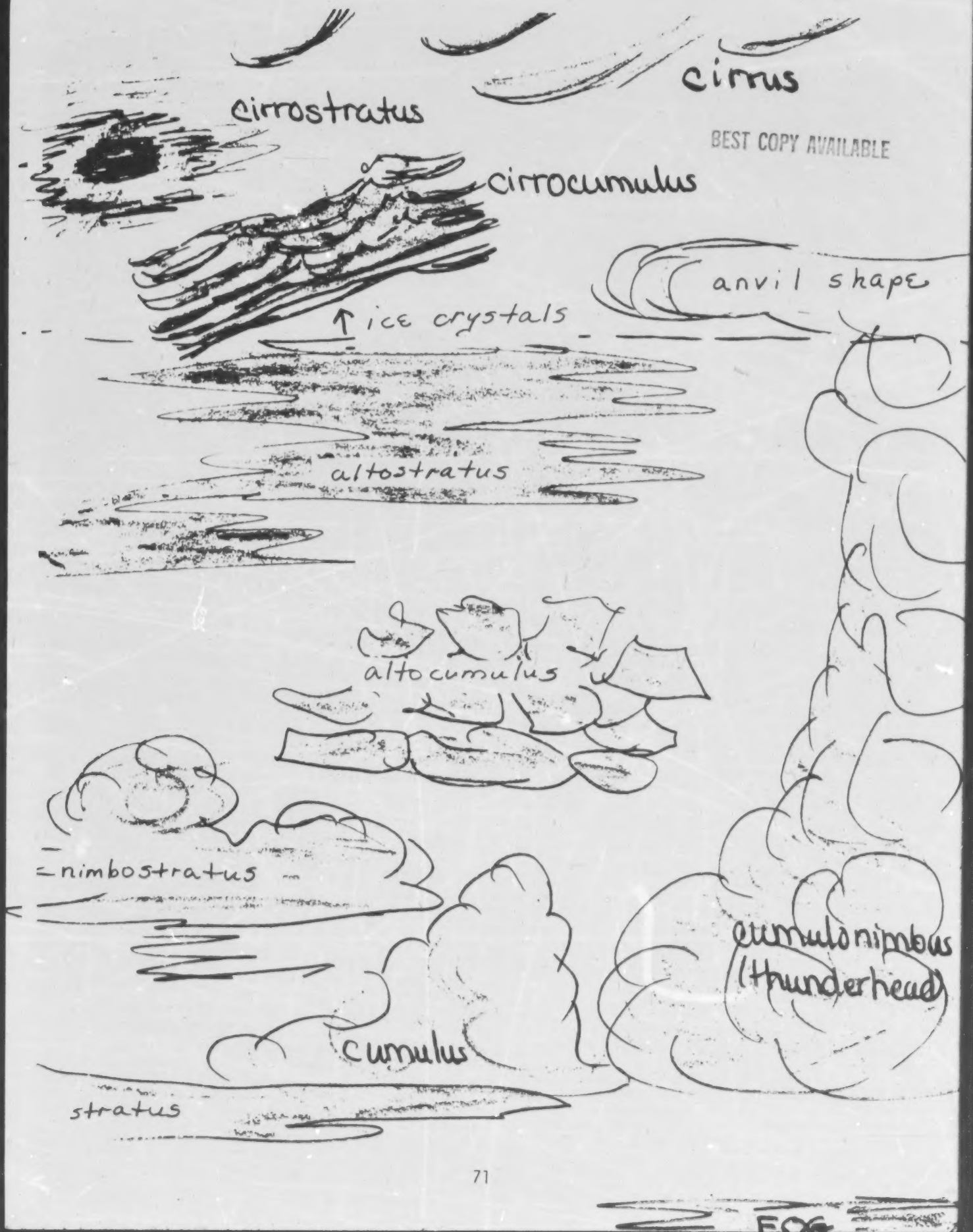

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INSTRUCTIONAL SEQUENCE
(Part III)

Concept Number		
I.	1.	Introduce the concept of "relative humidity." Discuss the fact that it is a percentage and that differences in temperature affect the amount of water the air can hold.
	2.	Discuss the barometer.
	*3.	Reinforce the concept of "relative humidity." Discuss the how and why of the hygrometer. Have the children fill out Data Sheet #1.
	*4.	Reinforce the how and why of the barometer. Each student should read the barometer with your assistance, and record the barometric reading on Data Sheet #2.
	*5.	Help the students determine the maximum and minimum temperatures for the last 24 hours and record their findings on Data Sheet #2.
	6.	Have students, with your assistance, complete Data Sheet #2 using the thermometer, rain gauge, and the information given on Data Sheets #3 and #4.
	7.	Obtain a clean, dry milk bottle with a cardboard top. Blow into the bottle several times until a film of water forms along the sides. Why did blowing into the bottle cause moisture to form? Cover the bottle and put it in a warm place. The water should disappear. To prove that the water is still inside, place the covered obttle in a cool place. Where did the water seem to disappear when the bottle was placed in a warm place? Does this experiment prove there is moisture in the air? Why or why not?
	*8.	To demonstrate the principle of a thermometer in a simplified way, you will need a six-inch high bottle with a rubber stopper and an eight-inch long glass tube through the stopper. Fill the bottle half full of colored water. The bottom of the tube must be in the water. Place the bottle in a warm place. The water should rise in the tube. Why do you think that the water rose into the tube? Why did the bottle have to be placed in a warm place before the water would start to rise?
	*9.	To demonstrate evaporation and condensation, fill a jar with about one-quarter inch of water, being careful not to get the sides wet. Covering the jar, allow it to stand in the sunlight for one half hour or more. Water should condense on the sides and the top. Where did the water come from? What was the purpose of placing the jar in the sunlight? Try the same experiment without putting the lid on the jar.

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Concept Number

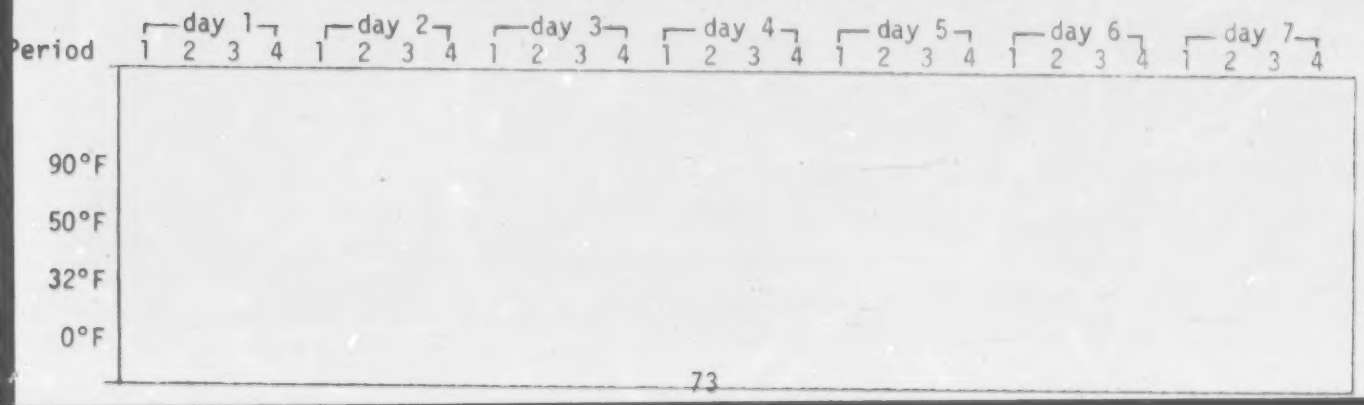
I. *10. To show that the temperature of water changes more slowly than that of solids, fill a bowl with soil and another with water. The temperature of each should be about the same. Measure the temperatures. Place both bowls in the sunlight for fifteen minutes; then take another temperature reading. Repeat the experiment, placing the bowls in the refrigerator for fifteen minutes. Prior to placing the bowls in the refrigerator, discuss possible outcomes of the experiment. What is the temperature of each now? Why do you think that there is a difference? Try the experiments again to see if you get the same results.

*11. To compare differing rates of evaporation, fill two saucers with the same amount of water. Place one in the sun, the other in a shady place. Check the water levels in the saucers after an hour. Why do we hang clothes out on a line to dry on a sunny day? Place saucers in windless places to compare the evaporation rate with those placed in breezy places. Discuss blowers installed to dry hands in some public restrooms. (Outdoor activity.)

*12. Have a group of children stand shoulder to shoulder in a small area to represent the molecules in cold air. Tell the group that the air has warmed to 80 degrees and have the children spread apart. If desired some children can represent water molecules and find a place to stand within the group. Then tell the group that the air has cooled to its original temperature and that they must go back and stand in their original places. There will be no room for the water molecules in the original space; they must fall as rain. (Outdoor activity.)

13. Using student data sheets and weathermen data sheets, have the students prepare a chart of the week's maximum and minimum temperatures, barometric pressures, and relative humidity. You will probably have several different readings of relative humidity and barometric pressure on the same day, depending upon the time at which they were taken. This will, of course, indicate the rises and falls for the week. Put the chart on the wall for discussion.

Example for Temperature: (Use red for maximum, blue for minimum.)



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Concept Number

I. *14. Have the students complete Data Sheet #6. Then discuss Concepts I and II, bringing out factors which affected their weather observations and predictions (for example, inaccurate reading, etc.). Tally correct and incorrect predictions on the board.

II. 15. Construct a large cloud in your classroom to illustrate the contents of a cloud. This project may be done either on a bulletin board or in the form of a mobile.

16. Have each child draw and label the contents of a cloud.

17. Overlays (transparencies) may be used to illustrate cloud contents: bottom sheet the cloud, one sheet dust, one sheet H_2O droplets.

18. Perform various experiments to illustrate how clouds are formed. (See experiment sheet following student data sheets.)

a. Rinse a milk bottle throughly with hot water. Fill the bottle with hot water to a depth of two to three inches. Place an ice cube on top of the bottle. Water evaporates from the hot water inside the bottle and rises with the warm air until it is cooled by the ice cube on top of the bottle. Fog is formed inside the bottle. The same thing happens in the formation of a cloud above the ground.

b. To illustrate pressure change, pump up a bicycle tire. When the air is compressed and in the tire, it is warm; but when released it is expanding and cooling.

c. To demonstrate evaporation, rub a wet sponge over a chalkboard. The water disappears because it has evaporated. The water that evaporates is the water vapor in the air which makes possible cloud formation.

d. To illustrate condensation, you will need: ice and a tin can. Dry the can and fill it with ice. Does the outside of the can stay dry? The ice made the can cold. The water vapor in the air is cooled when it touches the cold can, and changes to water droplets. This change to drops is known as condensation.

e. To demonstrate both evaporation and condensation, you will need a cup, water, ice, a hot plate, and a heat-proof coffee jar. Put a cup of water into the jar and heat it on the hot plate until hot, not boiling. Remove from the plate and put ice across the mouth of the coffee jar. Water vapor will fill the space and form tiny droplets in the shape of a cloud.

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Concept Number

II.

f. Another way to illustrate evaporation requires a teaspoon, 2 heat-proof pie plates, and a hot plate. Put one teaspoon of water in each pie plate. Heat one pie plate on the hot plate. Which teaspoon evaporates first? Hot water evaporates first; heat speeds up the process. The same thing happens when the sun heats rivers, lakes, bays, oceans, etc.

g. You will need a large glass jar, metal tray, ice cubes, and a flashlight to do this demonstration of condensation. Pour an inch of hot water into the glass jar. Cover it with a metal tray of ice cubes. Take the jar and tray into a dark room or closet and shine a flashlight towards the middle of the jar. You will see a small cloud. What is happening? The warm air is rising and when it reaches the metal tray full of ice cubes, the moisture in the air condenses and forms tiny droplets of water. When the droplets become large and heavy they fall as rain does.

*19. Have each child compile a booklet about clouds. Note the following:

a. What do the various clouds look like?

b. How high are the different kinds of clouds?

c. How much sky is covered by clouds?

d. What colors, shapes, and movements do you see?

e. What weather is the result of specific cloud types?

f. Which clouds are present before a storm?

g. What kind of weather do we have when no clouds are present?

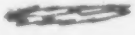
h. Which clouds are in the sky on a cold day?

i. Which clouds are in the sky on a warm day?

Weather symbols and chart data for possible use in the booklets:

Cumulus

Stratocumulus

Stratus 

Cumulonimbus

Nimbostratus

Altostratus (Hi)

Cirrostratus

Cirrocumulus

Dust Storm

Occasional snow *

Continuous snow * *

Clear sky

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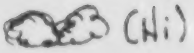
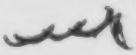
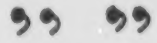
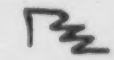
Altoscumulus  (Ni)	Half clouded
Cirrus 	100% overcast
Obscured	Occasional drizzle
Fog	Continuous drizzle 
Occasional rain	Lightning
Steady rain	Thunderstorm 

Recorded or chart

Month, date, year, time	Clouds
Temperature	Dew point
Precipitation	Sky
Wind direction and speed	Forecast
Barometric pressure	Remarks
Relative humidity	

Concept Number

III. 20. Collect pictures of cloud types and formations.

*21. Take pictures of cloud types and formations.

*22. Take a motion picture of cloud changes and movements.

23. Construct a mobile of cloud types. Incorporate the sun and show its movement and the covered areas. Cardboard, construction paper, or cotton puffs are only some of the possible media to use.

24. From a cloud illustration or photograph one may imagine a person, place, or thing. The children may turn illustrations into real things. Have the stu-ents imagine that they are clouds and compose a story.

25. Make clouds with sponge printing. Other printing media such as vegetables may be used.

26. Use crayons or wax to make cloud shapes and paint over them with water paint (resists).

27. Torn paper or newspaper may be used to make cloudy or rainy day scenes.

28. Clouds can be formed using the spatter paint method.

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29. Children may develop slides or transparencies showing the main cloud types and their variations.

30. Cardboard box sculptures with symbols and cloud illustrations may be piled high in a classroom.

31. From their observations children may put together a chart, construct a weather station, keep records, predict, and make analogies.

32. Clip weather predictions from the newspaper. How often are they right? Wrong? Change?

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Name _____
School _____
Date _____
Time _____

RELATIVE HUMIDITY
STUDENT DATA SHEET #1

Directions: With the aid of a psychrometer or wet and dry bulb thermometers, and the accompnaying chart, find the relative humidity of the air.

a. Dry-bulb reading: _____ degrees Fahrenheit.

b. Wet-bulb reading: _____ degrees Fahrenheit.

c. Difference between readings: _____ degrees Fohrenheit.

d. Relative humidity: _____ percent.

TABLE FOR FINDING RELATIVE HUMIDITY (Percentages)

Dry-bulb reading	Difference between Dry- and Wet-bulb Thermometer Readings																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
30	89	78	68	57	47	37	27	17	8	—	—	—	—	—	—	—	—	—	—	—	—
32	90	79	69	60	50	41	31	22	13	4	—	—	—	—	—	—	—	—	—	—	—
34	90	81	72	62	53	44	35	27	18	9	1	—	—	—	—	—	—	—	—	—	—
36	91	82	73	65	56	48	39	31	23	14	6	—	—	—	—	—	—	—	—	—	—
38	91	83	75	67	59	51	43	35	27	19	12	4	—	—	—	—	—	—	—	—	—
40	92	84	76	68	61	53	46	38	31	23	16	9	2	—	—	—	—	—	—	—	—
42	92	85	77	70	62	55	48	41	34	28	21	14	7	0	—	—	—	—	—	—	—
44	93	85	78	71	64	57	51	44	37	31	24	18	12	5	—	—	—	—	—	—	—
46	93	86	79	72	65	59	53	46	40	34	28	22	16	10	4	—	—	—	—	—	—
48	93	87	80	73	67	60	54	48	42	36	31	25	19	14	8	3	—	—	—	—	—
50	93	87	81	74	68	62	56	50	44	39	33	28	22	17	12	7	2	—	—	—	—
52	94	88	81	75	69	63	58	52	46	41	36	30	25	20	15	10	6	0	—	—	—
54	94	88	82	76	70	65	59	54	48	43	38	33	28	23	18	14	9	5	0	—	—
56	94	88	82	77	71	66	61	55	50	45	40	35	31	26	21	17	12	8	4	—	—
58	94	89	83	77	72	67	62	57	52	47	42	38	33	28	24	20	15	11	7	3	—
60	94	89	84	78	73	68	63	58	53	49	44	40	35	31	27	22	18	14	10	6	2
62	94	89	84	79	74	69	64	60	55	50	46	41	37	33	29	25	21	17	13	9	6
64	95	90	85	79	75	70	66	61	56	52	48	43	39	35	31	27	23	20	16	12	9
66	95	90	85	80	75	71	66	62	58	53	49	45	41	37	33	29	26	22	18	15	11
68	95	90	85	81	76	72	67	63	59	55	51	47	43	39	35	31	28	24	21	17	14
70	95	90	86	81	77	72	68	64	60	56	52	48	44	40	37	33	30	26	23	20	17
72	95	91	86	82	78	73	69	65	61	57	53	49	46	42	39	35	32	28	25	22	19
74	95	91	86	82	78	74	70	66	62	58	54	51	47	44	40	37	34	30	27	24	21
76	96	91	87	83	78	74	70	67	63	59	55	52	48	45	42	38	35	32	29	26	23
78	96	91	87	83	79	75	71	67	64	60	57	53	50	46	43	40	37	34	31	28	25
80	96	91	87	83	79	76	72	68	64	61	57	54	51	47	44	41	38	35	32	29	27
82	96	91	87	83	79	76	72	69	65	62	58	55	52	49	46	43	40	37	34	31	28
84	96	92	88	84	80	77	73	70	66	63	59	56	53	50	47	44	41	38	35	32	30
86	96	92	88	84	80	77	73	70	66	63	60	57	54	51	48	45	42	39	37	34	31
88	96	92	88	85	81	78	74	71	67	64	61	58	55	52	49	46	43	41	38	35	33
90	96	92	88	85	81	78	74	71	68	64	61	58	56	53	50	47	44	42	39	37	34
92	96	92	89	85	82	78	75	72	69	65	62	59	57	54	51	48	45	43	40	38	35
94	96	92	89	85	82	78	75	72	69	66	63	60	57	54	52	49	46	44	41	39	36
96	96	93	89	86	82	79	76	73	70	67	64	61	58	55	53	50	47	45	42	40	37
98	96	93	89	86	82	79	76	73	70	67	64	61	58	56	53	51	48	46	43	41	39
100	96	93	90	86	83	80	77	74	71	68	65	62	59	57	54	52	49	47	44	42	40

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Name _____

School _____

STUDENT DATA SHEET #2

WEATHER OBSERVATIONS

1. Day and Date _____ Time _____
2. Present temperature . . . . . _____

   Maximum temperature for last 24 hours . . . . . _____

   Minimum temperature for last 24 hours . . . . . _____
3. Present barometer reading . . . . . _____

   Direction of change: Rising_____ Falling_____ Steady_____
4. Relative humidity . . . . . _____
5. Sky conditions (clear--no clouds; partly cloudy--less than half the sky covered; mostly cloudy--more than half the sky covered; overcast--no blue sky can be seen) . . . . . _____
6. Wind speed (calm--no air motion; breezy--leaves in motion; windy--tree limbs moving; very windy--tree trunks bent) . . . . . _____
7. Wind direction (named in direction from which the wind comes) . . . . . _____
8. Rainfall since last reading . . . . . _____

   Rainfall in last 24 hours . . . . . _____

WEATHER FORECAST

_____

_____

_____

ACTUAL WEATHER

_____

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Name_____

School_____

STUDENT DATA SHEET #3

BAROMETER

A barometer is an instrument which measures the pressure of the air. It is used chiefly in forecasting weather, in measuring heights of mountains, and in measuring aircraft altitude.

THE BAROMETER AND WEATHER

The barometer has made it possible to forecast the changes in weather for days ahead.

Falling Barometer

1. A rapid fall indicates stormy weather.
2. The rapidity and total amount of fall help determine the severity and duration of unfavorable weather. A slow, steady fall usually means disagreeable weather for several days. A rapid fall usually means a more severe storm of short duration.

Rising Barometer

1. A gradual, steady rise indicates settled and clear weather.
2. A rapid rise indicates unsettled weather - possibly a slight storm.
3. A rising barometer during wet weather usually means fair weather is on the way.

Steady Barometer

1. A steady barometer during normal seasonal weather indicates continued good weather.
2. A steady barometer during a stormy season indicates continued unfavorable weather.

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STUDENT DATA SHEET #4

PREDICTIONS BASED ON WIND DIRECTION AND BAROMETRIC PRESSURE

(29.3 in. = very low; 30.0 in. = average; 30.50 in. = high)

Wind from SW to NW:

High and steady	fair for 1 to 2 days
High and rising rapidly	fair and warmer, rain within 2 days
High and falling slowly	rain in 24-36 hours
Very high, falling slowly (30.20)	fair and rising temperatures for 2 days

Wind from S to SE:

High and falling slowly	rain within 24 hours
High and falling rapidly	rain within 12 to 24 hours

Wind from SE to NE:

High and falling slowly	rain within 12 to 16 hours
High and falling rapidly	rain within 12 hours
Low and falling slowly	rain continuing 1 or more days
Low and falling rapidly	rain within a few hours, clearing within 36 hours

Wind from E to NE:

High and falling slowly	fair and light winds, rain in 3 days
High and falling rapidly	rain in 12 to 24 hours

Wind from S to SW:

Low and rising rapidly	clearing within a few hours fair for several days

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Student Data Sheet #4 (Continued)

Wind from S to SE:	
Low and falling rapidly.	severe storm within a few hours, then clear within 24 hours
Wind from E to N:	
Low and falling rapidly.	severe storm in a few hours, heavy rains
Wind swinging to W:	
Low and rising rapidly	end of storm, clear and cooler
Wind from W to NW:	
Low and falling rapidly.	clearing and cooler

STUDENT DATA SHEET #5

Name _____

STUDENT DATA SHEET FOR WEATHERMEN

School _____

DATE	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Maximum temperature							
Minimum temperature							
Barometric reading							
Direction of change of barometer (rising, falling, steady)							
Sky conditions (clear - no clouds; partly cloudy - less than half the sky covered; mostly cloudy - more than half the sky covered; overcast - no blue sky can be seen)							
Wind speed (calm - no air motion; breezy - leaves in motion; windy - tree limbs moving; very windy - trees trunks bent)							
Wind direction (named in direction from which wind comes)							

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STUDENT DATA SHEET #6

Name _____

School _____

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
Date								
Predicted Weather								
Actual Weather								

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EXPERIMENT SHEET

1. What did we use?

2. What did we do?

3. What happened?

4. What did we prove?

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PART IV

PRECIPITATION AND THE WATER CYCLE

CONCEPTS
(Part IV)

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I. Precipitation takes place when water returns to the earth in different forms.

II. There are many types of precipitation; each affects us and our environment in different ways.

III. Different parts of the world receive varying amounts of rainfall.

IV. Water, although in many forms, is used over and over again. This is called the water cycle.

BEHAVIORAL OBJECTIVES
(Part IV)

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Concept Number		
I.	1.	At the end of the unit on precipitation, ninety percent of the children will be able to distinguish four forms of precipitation in a given set of pictures.
II.	2.	Upon completion of the unit on precipitation, eighty-five percent of the children will be able to list orally or in writing four different types of precipitation and describe two ways in which each affects man, other animals and/or plants.
III.	3.	Ninety percent of the children will be able to describe the effects of rainfall amounts on a desert, a jungle, and the South Pole.
IV.	4.	Upon completing the unit, ninety percent of the class will be able to draw and label, or to explain orally or in writing, the steps involved in the water cycle.

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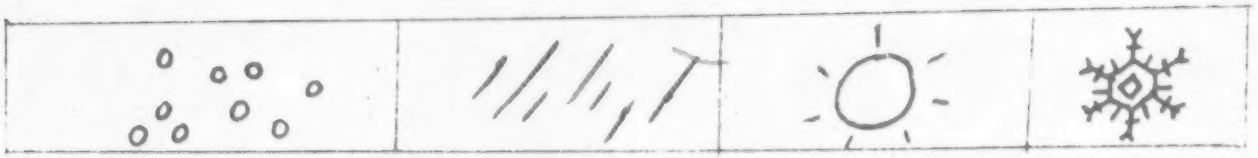
PRE-POST TEST
(Part IV)

1. a. Draw a line around the rain.

   b. Put an X on the snowflake.

   c. Draw a line under the hail.



2. a. List two different kinds of precipitation and describe two ways in which each affects us.

   b. From a collection of pictures or magazine clippings, select a picture of one type of precipitation. Describe (orally) the precipitation and three possible reasons for it.

   c. Draw a picture of one type of precipitation and describe in a written paragraph at least three possible reasons for that particular type of precipitation.

3. Match the letter with the number preceding the group of words that describes the effect of precipitation in these geographical areas.

   a. desert ____

   b. South Pole ____

   c. jungle ____

   (1) icebergs, very cold, no plant life, much snow

   (2) lizards, cacti, very hot, dry

   (3) lots of plant life, very hot and humid, monkeys

4. Draw an arrow in the box to show whether water which is warmed by the sun goes up into the air ↑ or down into the ground. ↓ □

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5. Draw and label or explain the different stages of a water cycle.

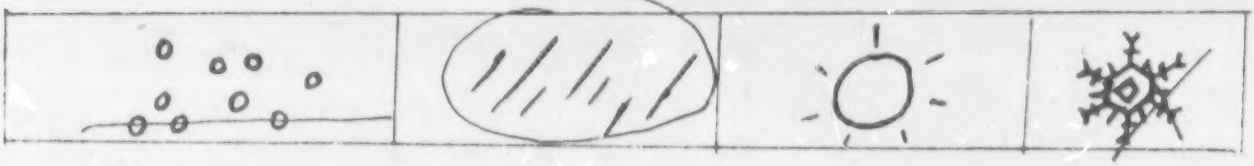
ANSWER SHEET
PRE-POST TEST
(Part IV)

BEST COPY AVAILABLE

1. a. Draw a line around the rain.

   b. Put an X on the snowflake.

   c. Draw a line under the hail.



2. a. List two different kinds of precipitation and describe two ways in which each affects us. Answers will vary. Examples:
   rain - makes things grow, spoils picnics, washes pollution from the air
   snow - stops traffic, makes it possible for us to build a snowman, makes it necessary for us to wear a coat

   b. From a collection of pictures or magazine clippings, select a picture of one type of precipitation. Describe (orally) the precipitation and three possible reasons for it.

   c. Draw a picture of one type of precipitation and describe in a written paragraph at least three possible reasons for that particular type of precipitation. Answers will vary. Examples:

   clouds, temperature, wind, elevation

3. Match the letter with the number preceding the group of words that describes the effect of precipitation in these geographical areas.

   a. desert 2

   b. South Pole 1

   c. jungle 3

   (1) icebergs, very cold, no plant life, much snow

   (2) lizards, cacti, very hot, dry

   (3) lots of plant life, very hot and humid, monkeys

4. Draw an arrow in the box to show whether water which is warmed by the sun goes up into the air ↑ or down into the ground. ↓ ↑

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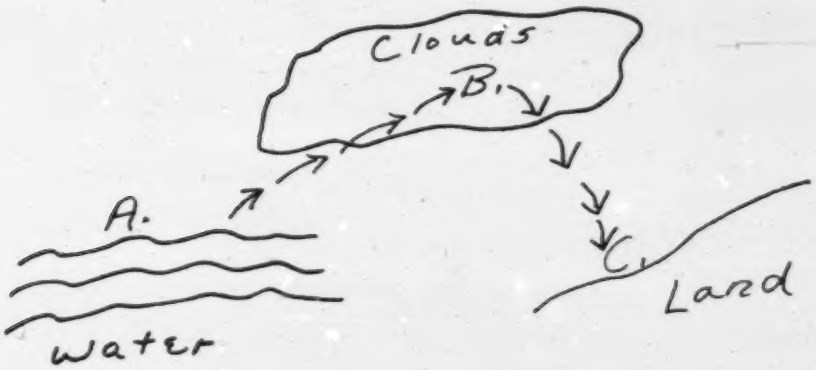
5. Draw and label or explain the different stages of a water cycle.

   (A) Evaporation, (B) Condensation, and (C) Precipitation should be shown by using arrows.



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BACKGROUND INFORMATION
(Part IV)

Concept I & II

Rain

Although every cloud contains water, not every cloud produces rain. Air tosses about the tiny drops of water as the clouds move. Two droplets bump into each other making a larger droplet. Gradually, the droplets become bigger and heavier. When they begin to fall toward earth, they are raindrops.

Ice crystals may be present in the very high clouds. They are also tossed in the air. When they meet they may stick together and form larger crystals. When the crystals are big and heavy, they start to drop. If they pass through a layer of warm air, they melt and come down to earth as raindrops.

Sometimes when it rains the clouds are so high that you cannot see them. As the raindrops fall, the clouds are blown away and you see raindrops but not the clouds.

The same amounts of rain do not fall in all parts of the world. The amount and time of year of the rainfall helps determine plant growth, types of animals, kinds of clothing worn, and even the houses in which people live. Scientists can measure rainfall with a ruler or yardstick to learn how deep the rain would be if it did not run off or soak into the ground. In the United States, Nevada is the driest state with only 9 inches of rainfall a year; Louisiana is the wettest with about 55 inches.

India has the heaviest rainfall in the world. One place in India received more than 1,000 inches of rainfall in a year. One section of Chile, on the other hand, had less than one inch of rain in 43 years.

Sometimes rain falls slowly; at other times it comes down very quickly. Only 1/10 to 3/10th of an inch of rain falls per hour in a moderate rain. One place in Texas, however, had 20 inches of rain in a three-hour period.

When a large amount of rain falls in a short period of time, it is usually called a cloudburst. People say, "It's raining cats and dogs!" or "The rain is coming down in sheets!" or "It's raining pitchforks!" The water runs down the streets in rushing brown rivers, sometimes carrying rocks and gravel.

Sometimes it just drizzles. Other times the rain comes down in such fine droplets that it seems like a thick fog and you can scarcely see any drops falling.

The amount of rainfall depends upon the amount of moisture in the clouds and on the air temperature and wind motion. When you blow your warm breath against a cold window pane, moisture forms on the glass. In a cloud, there must be something for water to form on, too. Clouds contain tiny dust particles which are too small for us to see, but moisture clings to them. This is the start of a raindrop or a snowflake.

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Concept II

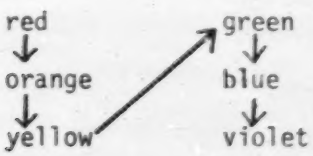
Scientists are learning how to speed up rain-making in clouds which have few or no dust particles in them. They call this process "seeding" the clouds. The clouds are sprayed with a chemical called silver iodide to which moisture can cling. The questions which scientists are still trying to answer is whether the cloud would eventually have produced rain anyway.

You can make rain in the classroom. You will need a teakettle half full of water, some ice cubes, and a small electric hotplate. Heat the water in the teakettle until a cloud (steam) forms several inches from the spout when the water vapor hits the cooler air. Hold the pan of ice cubes in the middle of the cloud of steam, cooling the moist air even more. Large drops of water will appear on the outside of the pan. As they start to drip onto the floor, it will be "raining."

Sometimes toward the end of a summer rain shower you will see a rainbow in the sky. If you face the sun, you will miss it. You will see a rainbow only if the sun is at your back. If, while it is still raining, the sun shines through the clouds, a rainbow will bend across the sky. The ancient Norsemen called this arch of many colors "The Bridge of the Gods."

Rainbows are caused by sunlight shining through drops of water in the air. The raindrops break up the sunlight into the spectrum of colors of which light is made.

Rainbows appear and disappear quickly. Observe the order of the colors in a rainbow from top to bottom:



Watch for tiny rainbows in waterfalls, fountains, and spray from the garden hose.

You can also make miniature rainbows of your own. Dip the top of a soda bottle into soapy water so that a film forms across the opening. Let sunlight pass through the curved glass and strike the soapy film. The colors which you see are those of a rainbow.

Snow

It is always so cold when snow falls that water vapor in the air freezes. This is what makes snowflakes.

People living on one-third of the earth's surface never see snow, even from afar. Snow never falls in their area. Many people who do live where snow falls never see what snowflakes are really like.

Snowflakes are shaped in many crystal patterns. Dr. Wilson A. Bentley of Vermont spent most of his life taking over 6,000 photographs of snowflakes. His work helped to show that each snowflake is different, yet each is hexagonal, containing six sides.

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When under pressure, snowflakes turn into ice; this is the way in which glaciers (rivers of ice) are formed. Glaciers are formed when snow accumulates in large amounts above the "snow line," where even in summer temperatures are so cool that some of the snow does not melt. Each year additional amounts pile up. The more recent layers press down upon the older layers and pack the deep snow into grains resembling hailstones. Deeper down, additional pressure crams the grains together and forces them into crystals of pure ice.

The mass of ice is solid but its crystals shift around under pressure. Through constant shifting and turning of the ice crystals, as the forces of gravity are at work, the mass of ice moves and flows. The movement is very slow, as little as seven and one-half inches a day.

The snow which built glaciers came from evaporated ocean water. Because the oceans lost so much water, the sea level fell until it was at one time at least 200 feet lower than it is at present.

One of the last glaciers pushed down the Mississippi Valley as far as the present-day site of St. Louis. Scientists believe that the thickest part of that particular glacier reached a depth of more than three miles.

A cold climate is made colder because an ice sheet is white, and white surfaces absorb the least amount of heat. For the same reason we wear light-colored clothing in summer; it tends to bounce the heat rays from the sun away from us.

If you let a snowflake fall onto your mitten and observe it through a magnifying glass, you will be able to count the six sides. You will also see that each snowflake is different.

Sometimes snowflakes are wet and sticky, making slushy snow. When snowflakes are light, dry, and fluffy, snow activities are fun.

Is snow beneficial for any purposes other than fun?

Snow is a blanket which covers plants and protects them from ice, wind, and low temperatures. Snow-covered plants can survive through the cold winter season; snow is good for plants.

Snow also forms a blanket over the ground to protect animals from cold winds and air temperatures. You can prove the snow keeps in warmth. You will need two thermometers. Hang one from a tree and bury the other in the snow. An hour later, check and record both temperatures. Which is lower?

Snow also protects people. All Eskimo houses are called "igloos." The ingenious snow houses made by the Canadian Eskimos are built of blocks of hard snow which are cut and shaped with a snow knife. In very cold weather, the blocks freeze to the ground and to each other in ten minutes. The skill of the Eskimos is such that they are able to build a snow house in less than an hour.

Snow is helpful in other ways. Melted snow provides water for our rivers and streams. Melting snow sinks slowly into the soil causing it to crumble. In the spring, the sun warms the soil. Plants grow well in this loose, moist, warm soil; thus food producing plants thrive.

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But snow can also cause harmful conditions for man. Deep winter snows may melt in the warm spring sun. If there is too much water for the streams to carry, they overflow and cause flooding in towns, cities, and farmlands.

When it is snowing and a strong wind blows, the quiet snow becomes a fierce blizzard. Houses, roads, sidewalks, and cars are covered with snow. Life becomes difficult for animals and people.

Snowflakes melt when they touch your warm hands. They are made of frozen water vapor, rather than of frozen raindrops as are sleet and hail. Water which floats in the air and is invisible is called water vapor. When water vapor freezes in upper air it turns to tiny crystals of ice which fall to earth as snowflakes.

A single snowflake may be as large as one-half inch in diameter. It would take sixteen to thirty-two of these snowflakes to make an inch-long line. Since many snowflakes are much smaller, it might take as many as two hundred to make a line one inch long.

Because snowflakes are fluffy and irregular in shape, they pile up with air pockets between them. To get one inch of water you would need to melt ten inches of snow; the rest is just air. It is the presence of this air which makes a "snow blanket" very light. For this reason some animals can sleep or hibernate all winter after they have buried themselves in snow.

Because snowflakes have sharp points, they are able to cling to one another. This enables them to pile up two to three inches high on slender twigs, or five to six inches deep on top of fenceposts.

Four to fourteen inches of snow on the ground does no harm, although it may cause inconvenience; but just a few inches on wires and branches can cause them to break under the weight of the snow. You can help protect trees and bushes in a heavy snowstorm by shaking the snow off their branches before too much accumulates.

We think of snow as being colorless or off-white, but when the sun is reflected off the crystals, snow can be blinding white. Green, black, and red snow has been known to fall also, caused by the color of the fungi or dust particles around which the snowflakes have formed.

Hail and Sleet

A hailstone starts out as a raindrop in a thundercloud. The raindrop freezes in an upper cloud. As it starts to fall, an air current lifts it again. The frozen raindrop may make several trips up and down. With each trip it may pick up more moisture adding another layer of ice. If you slice a hailstone in half, you will see the many layers of ice which look like the layers of an onion. Hail is likely to occur on a hot afternoon during a thunderstorm. The hail usually looks like ice marbles, but sometimes hailstones may be as large as baseballs. One found in Nebraska weighed one and a half pounds.

Hailstones can cause considerable damage. When hail hits a farmer's crops, the fruit in his orchard is filled with holes and knocked to the ground. His wheat fields are flattened; his tobacco leaves are cut to shreds. Livestock on his farm may also be injured. Our windows are often

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shattered; our automobiles may be damaged.

Sleet usually comes in cold weather and is smaller than hail. Sleet does not bounce up and down in a cloud as hail does, but it can hit the earth with enough force to bounce on the ground. Both hail and sleet are frozen before they hit the earth.

If rain freezes after it hits the earth, a glaze of ice is formed over everything. This occurs when very cold rain strikes cold surfaces. The glaze thickens as additional rain falls. Every twig may become covered with glaze; electric wires and fences also become coated with ice. If the glaze is very heavy, branches and wires break, poles bend, trees splinter, and cars slide about.

Dew and Frost

When you walk through the grass on an early summer morning, your feet or shoes will probably get wet because the grass is wet. Why? It did not rain during the night and yesterday afternoon the grass was dry. The beads of water which you see clinging to each blade of grass and sparkling in the cobwebs is dew.

Dew forms right where you see it. It does not fall from clouds like rain. It is water vapor which has condensed to drops of water. The summer air is often heavy with water vapor. The earth and grass cool quickly when the sun no longer warms them. Water vapor cools and turns into the tiny beads of water called dew.

The same phenomenon occurs if you wear glasses and come into a warm room from the cold outside air. Sometimes window glass is cooled. When the warm, moist indoor air touches the cool glass, water vapor in the air changes to water and a film of dew covers the inside of the window.

If the weather is very cold, the water vapor freezes as it touches the cold glass. The tiny crystals which form are frost. They make a lacy design on the window. Frost is not frozen dew. The water vapor has changed directly to frost. This can happen only when the temperature is 32° F. or less. During the winter it is frost, rather than dew, which may form when the ground and grass are cold. Water vapor in the air freezes as it touches them. Then sparkling frost crystals cover the ground.

Dew and frost are not likely to form when there is a strong wind. Air which is kept moving is not likely to be cooled by the earth's surface. In addition, clouds prevent heat from leaving the earth quickly and water vapor in the air is not cooled sufficiently to cause either dew or frost to form.

Look for dew or frost in the early morning. As the sun warms the air, they disappear.

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FORMATION OF A HAILSTONE

CROSS SECTION OF A HAILSTONE

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Concept IV

Water: Up and Down and Around (The Water Cycle)

We can easily see water which comes down from the air to the earth in the form of rain or snow, hail or sleet. It is harder to see that water also goes back up into the air from the earth. People who lived a long time ago did not realize this.

Dry, hot air causes water to disappear quickly. You know that when you hang up a wet swim suit the water disappears. The drying process takes longer if the air is cold and moist. Water in the swim suit changes to water vapor, which moves into the air. The water evaporates. Since you cannot see water vapor, you cannot see evaporation.

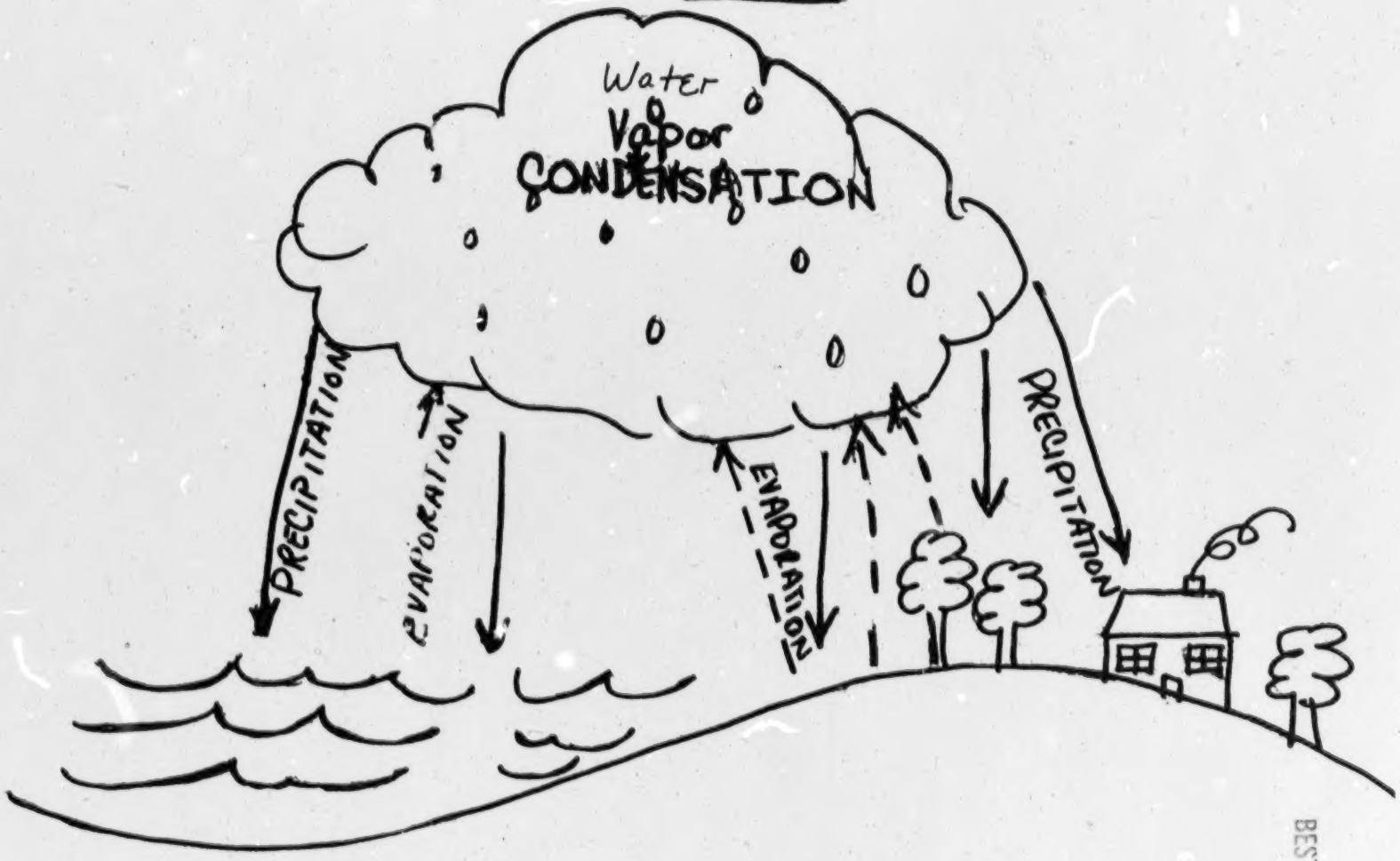
When the air is hot and dry it can take up water more easily. The evaporation process is also speeded up if the wind is blowing, because more air touches the wet surface. On a cool, cloudy day the air is moist and so full of water that it cannot take up any more. The evaporation process is slowed down.

Water evaporates from lakes, rivers, and ponds. It evaporates from rain puddles, from the ocean, and even from plants. On a sunny day a sunflower gives off a pint of water in the form of water vapor. A large oak tree may give off 200 gallons of water in a day.

Humidity is the amount of water in the air. Warm air is able to hold more water than cool air. Sometimes the air is so full of water that it cannot hold anymore. This is the saturation point. Cooling the warm, moist air causes it to lose some of its water vapor. This water vapor may fall back to the earth in the form of rain, hail, snow, or sleet.

The process whereby water vapor changes to water is called condensation. Water vapor condenses and becomes dew when it touches the cool grass. The dew evaporates when it disappears as it is warmed by the sun. It has changed to water vapor and we can no longer see it. Water is always going up and coming down. It evaporates from the earth and goes into the air as water vapor. Later on, after it condenses, it comes down again as rain, hail, sleet or snow. Round and round it goes.

HYDROLOGICAL CYCLE



1) ⟶ precipitation from clouds
2) ⟷ evaporation from water and land
3) transpiration from plants
4) Condensation of vapor to liquid form

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INSTRUCTIONAL SEQUENCE
(Part IV)

Concept Number

I. *1. You can make rain in the classroom. You will need a teakettle half full of water, some ice cubes, and a small electric hotplate. Heat the water in the teakettle until a cloud (steam) forms several inches from the spout when the water vapor hits the cool air. Hold the pan of ice cubes in the middle of the cloud of steam thus cooling the moist air even more. Large drops of water will appear on the outside of the pan. As they start to drip onto the floor, it is "raining."

*2. The amount of rainfall is carefully measured by the United States Weather Service in inches. Using a drinking glass with straight sides and a six-inch rules, you can make a simple rain gauge. Fasten the ruler to the outside of the glass with tape; be sure the ruler does not touch the table or the measurement will not be accurate. When the weather looks as though it is going to rain, put the empty glass outdoors in an open area away from trees and buildings. After the rain ends, place the glass on a flat surface and see how high the water level is.

*3. Take a magnifying glass and a piece of dark cloth outdoors on a snowy day. Place an easily observable snow crystal on the cloth and count its sides or points. Fill a glass with snow. How much water will be in the glass when the snow melts? Measure before and after melting to determine how many inches of snow are necessary to make one inch of water.

*4. If handled carefully, snowflakes can be preserved on glass slides. You will need a collecting board covered with black velvet, a small-pointed glass rod, a glass slide, and a resin solution. After the snowflakes have fallen onto the velvet, take a half drop of resin solution and put it on the glass slide. With some of the solution still on the tip of the rod, touch it to one of the snowflakes and pick it up gently. Carefully touch the snowflake to the droplet on the slide. It will envelope the snowflake and quickly harden, leaving a hollow shell of the snowflake.

5. Think of rain falling on a dirt field, a wooden bridge, a city street, the top of a car, etc. What words can you think of, either real or "made up," which would describe the sound the rain is making? Try writing a poem similar to this one:

Weather Is Full of the Nicest Sounds
by Aileen Fisher

Weather is full
Of the nicest sounds:

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it sings
and rustles
and pings
and pounds
and hums
and tinkles
and strums
and twangs
and whishes
and sprinkles
and splishes
and bangs
and mumbles
and grumbles
and rumbles
and flashes
and CRASHES.
I wonder
if thunder
frightens a bee,
a mouse in her house,
a bird in a tree,
a bear,
or a hare
or a fish in the sea?
Not me!

Concept Number

6. Think of two words which, when put together, make a new word. (mail man: mailman) Using the words rain and snow, add other parts to each to form compound words.

II. 7. Clothing protects us during different kinds of weather. What special clothes would you wear to school on a cool, rainy day? How would clothes such as these protect you?

8. What safety precautions should be taken on a wet or icy day? Discuss safety when walking, riding a bicycle, or using play equipment when the weather has been rainy and/or icy.

9. Discuss the various types of weather reports. How can learning about the day's weather help you if you hear that precipitation is in the forecast? Suppose you heard the following forecast. How would you dress and plan for the day?

Local Weather Forecast

Mostly cloudy, 55% chance of showers.
Temperatures will remain in the mid to upper 40's.

Write some weather reports of your own.

*10. Of what importance is rainfall to a good harvest of fruit, vegetables, and grains? Make up or find songs of harvest - early American Indian songs, pioneer songs, etc. For additional activities, compose your own songs, relate rhythm band

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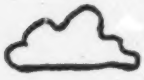
Concept Number

10. cont. instruments to it, create a dance, devise an Indian or pioneer harvest pageant, or string Indian corn which has been soaked in water.

11. Write a paragraph telling your favorite way of spending a rainy day at home.

*12. Look for dew on grass, flowers, and spider webs. Watch for frost on grass, window panes, and pumpkins. Look for signs of wind while it is raining or snowing.
Keep a weekly or monthly weather record showing:

sunny


cloudy

partly cloudy

snowy

rainy

windy

*13. Make your own frost inside the classroom. Remove the label from a large fruit can and fill it with ice cubes. Cover then with water. Add a little salt; stir for three or four minutes. The addition of salt lowers the freezing point and allows the water to get colder than 32°F (0°C). You will see a thin layer of frost on the outside of the can. Moisture in the air around the can condensed and froze when it came into contact with the tin can.

14. One of the largest hailstones ever found weighed one and a half pounds and was five inches in diameter. Draw a diagram to illustrate its size. Compare this size with a pea or pea-sized drawing.

Draw a cross-section of a hailstone showing the layers which formed as the hailstone fell and then accumulated more moisture as it was tossed back up into the freezing air again. If possible, slice a hailstone and count the number of trips it made before it fell to earth.

III. 15. Working either individually or in small groups, make shoebox dioramas depicting a jungle, desert, or glacial area.

16. Construct terrariums illustrating desert and jungles conditions. Consult local florists or greenhouses for suitable plants, planting media, and containers.

17. In Bergen, on the western coast of Norway, it rains on more than half of all the days in the year. If you lived in Bergen, you would need a raincoat often. How would you plan your day in view of the possibility of rain? How many days a year does it rain where you live? Keep a record of the number of days of rain in one month.

IV. 18. Using "Randy Raindrop" or "Ruthie Raindrop," follow him or her through the water cycle. Write descriptive paragraphs and make illustrations with captions.

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*20. Have each child draw a picture of the water cycle, and label the different phases (evaporation, condensation, and precipitation).

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PART V

MICRO-ENVIRONMENTS

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CONCEPT
(Part V)

Micro-environments are miniature environments within a larger environment.

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BEHAVIORAL OBJECTIVES
(Part V)

1. At the end of the unit on micro-environments all students, working in committees, will either construct or draw a micro-environment.

2. After completing the study of micro-environments, eighty percent of the students will be able to list two characteristics which show the contrast in weather conditions between the following sets of micro-environments:

   a. city - county
   b. valley - hill
   c. forest - open area

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PRE-POST TEST
(Part V)

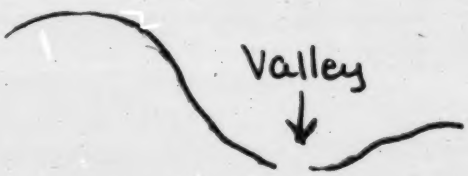
1. List two characteristics which show the contrast in weather conditions between each set of micro-environments.

A.

1. a. _____ 2. a. _____

b. _____ b. _____

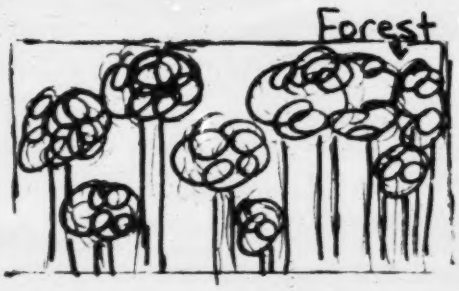
B.



1. a. _____ 2. a. _____

b. _____ b. _____

C.



1. a. _____ 2. a. _____

b. _____ b. _____

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ANSWER SHEET
PRE-POST TEST
(Part V)

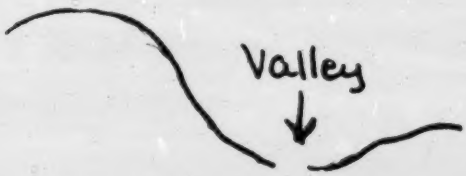
1. List two characteristics which show the contrast in weather conditions between each set of micro-environments.

A.

1. a. City has less rainfall.
   b. City has more clouds.

2. a. Country has more rainfall.
   b. Country has less clouds.

B.



1. a. Hill has higher temperature.
   b. Hill has less morning fog.

2. a. Valley has lower temperature.
   b. Valley has more morning fog.

C.

1. a. Forest is warmer in winter.
   b. Humidity is higher in forest.

2. a. Open area is warmer in summer.
   b. Humidity is lower in open area.

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BACKGROUND INFORMATION
(Part V)

Just as man has devised ways in which he can predict and to some extent control weather, he also has miniature environments, climates, or weather conditions to cope with. Micro-environments are small-scale environments, which vary in size, within a larger environment. These environments may be either beneficial or harmful depending on how man uses or adapts to the conditions. Geographical or man-made factors cause differences within the larger environment; the result is a micro-environment. For example, lakes cause differences in temperature and windflow. Plants create a change in their use of water and affect the winds. Windbreaks are planted for protection on farms. Cold air flows downhill and causes wind pockets in valleys. When choosing a site for a new dwelling, man must consider windflow, sunlight, drainage, frost, etc. When a large number of new dwellings or buildings have been placed in the same general area a city is formed. As the city grows, the change from a rural to an urban environment takes place.

Sample micro-environmental weather conditions:

Forest Versus Open Area

1. Forest is warmer in winter; open area is warmer in summer.
2. Windspeed reduced in forest; increased wind speed in open area.
3. Humidity higher in forest; humidity lower in open area.
4. Water storage higher in forest; lower water storage in open area.

Urban Versus Rural

1. City has more clouds, fog, smog, and haze than country.
2. City has higher temperatures than country because of buildings, narrow streets, acres of pavement, and conductiveness, all of which hold heat.
3. City has lower wind speed and less radiation than country because of uneven surfaces which reduce windspeed and increase turbulance.
4. City receives less rainfall than country.
5. City has less humidity than country because of the drainage of precipitation into sewers.

Valley Versus Hill

1. Valley has lower temperature, but larger range than hill.
2. Valley receives more night frost than hill.
3. Valley has more morning fog than hill.
4. Valley has lower night windspeed than hill.

VOCABULARY

1. Environment - surroundings which influence life. Micro-environment - miniature or small scale.

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INSTRUCTIONAL SEQUENCE
(Part V)

*1. Take a trip to a city and to the country. Compare the differences in weather conditions. (See city-country data sheet following activities).

   a. Set up models of both types of environments.

   b. What are some of the factors which cause the change in weather conditions?

   c. What has man done to form the environments?

   d. What has nature done to form the environments?

*2. Make your own micro-environment. The student may draw or illustrate his micro-environment or may explain it orally or in writing.

   a. Why did you make this type?

   b. Write a story about your micro-environment.

3. Construct dioramas, individually or in groups, which illustrate a micro-environment.

   a. Use a shoe box or a larger cardboard box.

   b. Real plants, etc. may be used.

   c. Any method which creates a closer simulation is encouraged; e.g., use of a light bulb to create heat, a fan for wind, or a water sprinkler for rain.

4. A diorama illustrating a comparison of micro-environments would further the activity.

5. Make a chart of factors which cause micro-environments.

*6. Explore micro-climates on different areas of the school grounds (temperature, wind, etc.).

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CITY-COUNTRY DATA SHEET

NAME:_____ DATE:_____

LOCATION:_____

DESCRIPTION OF CITY: [Include description of natural landforms, man-made land forms, weather (clouds, precipitation, humidity, wind, etc.), and control.]

DESCRIPTION OF COUNTRY: (Include same information as above.)

DRAWING OF CITY AND COUNTRY: (Sketch as many ideas or objects as possible to help you compare and contrast the two environments.)

Compare and contrast the two environments:

What has man done to change each environment? Can you see evidence of control or adaptation?

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Posters

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